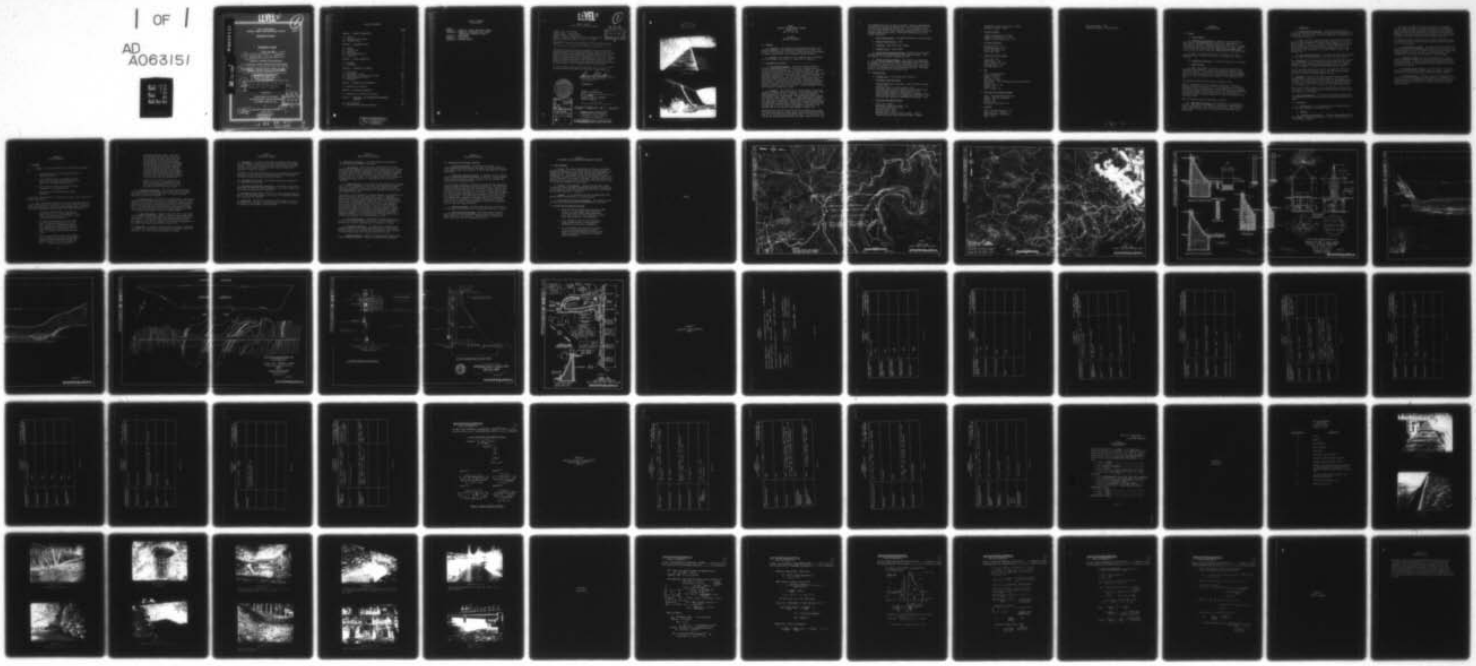
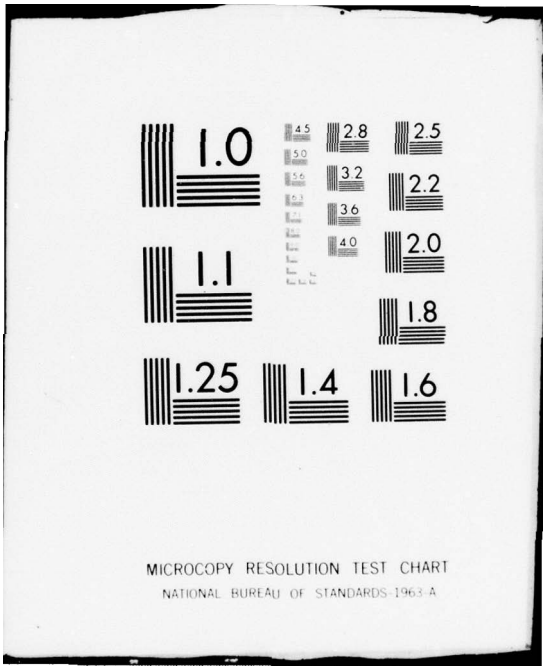
AD-A063 151 D'APPOLONIA CONSULTING ENGINEERS PITTSBURGH PA F/G 13/2
NATIONAL DAM INSPECTION PROGRAM. TUBMILL DAM (ID NUMBER PA 488)--ETC(U)
JUN 78 DACW31-78-C-0049
UNCLASSIFIED NL

1 OF 1
AD A063151



END
DATE FILMED
3-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL II

OHIO RIVER BASIN
TUBMILL CREEK, WESTMORELAND COUNTY

PENNSYLVANIA

TUBMILL DAM

ID NO. PA. 488

DACW31-78-C-0049

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

National Dam Inspection Program. Tubmill Dam (ID Number PA 488), Ohio River Basin, Tubmill Creek, Westmoreland County, Pennsylvania. Phase I Inspection Report.

PREPARED FOR

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF ENGINEERS
BALTIMORE, MARYLAND 21203

BY

D'APPOLONIA CONSULTING ENGINEERS
10 DUFF ROAD
PITTSBURGH, PA 15235

JUNE 1978

68p.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

LEVEL II

1

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

NAME OF DAM: Tubmill Dam
STATE LOCATED: Pennsylvania
COUNTY LOCATED: Westmoreland
STREAM: Tubmill Creek, tributary of Conemaugh River
DATE OF INSPECTION: April 25 and May 4, 1978

(cont'd p. 1)

ASSESSMENT: Based on the evaluation of the conditions as they existed on the dates of inspection and as revealed by visual observations, the condition of Tubmill Dam is assessed to be good.

The spillway does not have the recommended capacity to pass the probable maximum flood without overtopping. However, the dam is a masonry structure, and overtopping by the probable maximum flood would not significantly affect the stability of the dam. Therefore, the spillway capacity is considered to be adequate. However, during unusually heavy runoff when overtopping might occur, an around-the-clock surveillance plan should be implemented to detect possible problems, such as rapid erosion of the abutments.

It is recommended that the owner develop a formal warning system to alert downstream residents in the event of emergencies.

Lawrence D. Andersen

Lawrence D. Andersen, P.E.
Vice President

APPROVED BY:

G. K. WITHERS
Colonel. Corps of Engineers
District Engineer

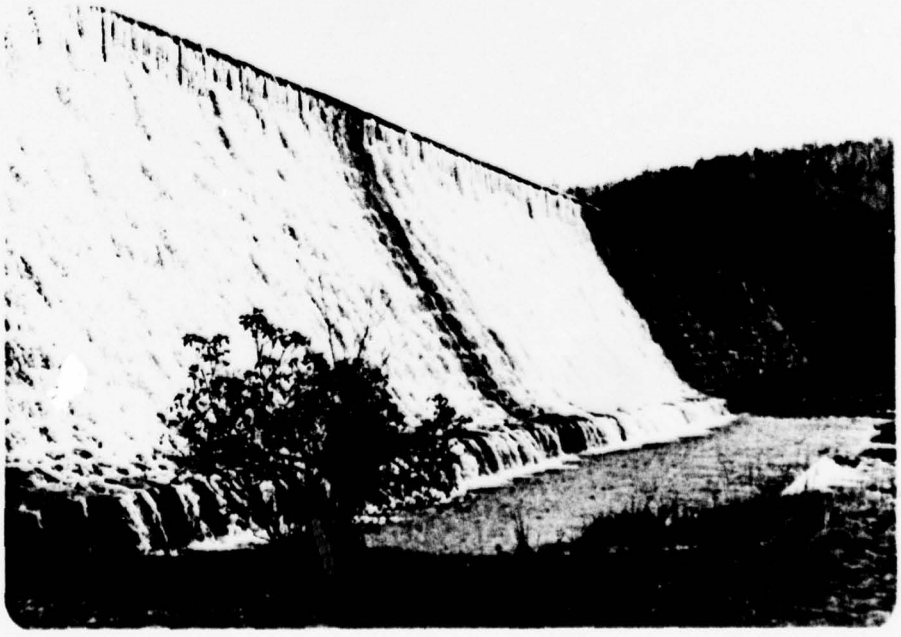
DATE: 6 Jul 78

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
Lawrence D. Andersen
ENGINEER
No. 17458-E

Contract DACW31-78-C-0044

TUBMILL DAM
NDS I.D. NO. 488
APRIL 25, 1978

Upstream Face



Downstream Face

PHASE I
NATIONAL DAM INSPECTION PROGRAM
TUBMILL DAM
NDS I.D. NO. 488

SECTION 1
PROJECT INFORMATION

1.1 General

a. Authority. The inspection was performed pursuant to the authority granted by The National Dam Inspection Act, Public Law 92-367, to the Secretary of the Army, through the Corps of Engineers, to conduct inspections of dams throughout the United States.

b. Purpose. The purpose of this inspection was to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project

a. Dam and Appurtenances. The dam is a masonry-gravity structure approximately 1100 feet long with a maximum height of 40 feet from the downstream toe. The single spillway is a 200-foot section of the dam which is two feet below the dam crest. The discharge spills down the face of the dam to a stone-paved apron and then into a plunge pool. The outlet works consist of a 30-inch cast-iron "blow-off" pipe and a 24-inch cast-iron supply line, both located near the right side of the spillway. Discharge through these pipes is controlled by valves located in the valve house near the toe of the dam. The 30-inch "blow-off" pipe constitutes the emergency drawdown facility for the dam. The dam impounds 614 acre-feet of water at normal pool level.

b. Location. The Tubmill Dam is located (Plate 1) six miles upstream on Tubmill Creek, a tributary of the Conemaugh River, five miles southeast of the town of Bolivar in Fairfield Township, Westmoreland County, Pennsylvania. The impounded reservoir serves as a domestic water supply source. A small impoundment estimated to have less than 1.5 acre-feet storage capacity is located one-half mile upstream of Tubmill Dam. Because the surcharge storage volume of Tubmill Dam (approximately 82 acre-feet) is much larger than the storage capacity of the upstream impoundment, a failure in the upstream dam is not likely to cause damage to Tubmill Dam.

Downstream from the dam, Tubmill Creek flows through a wide valley for about three miles to a point where the valley narrows and flows near an off-stream fishing pond (Mirror Lake). For the rest of its course, the stream meanders through the narrow valley and flows into

the Conemaugh River at the town of Bolivar. There are approximately 20 houses and one mobile home park in the first three-mile reach of the flood plain downstream from the dam. It is estimated, in the event of a dam failure, there would be considerable loss of lives and economic damage in this reach. Additional losses are also likely further downstream.

c. Size Classification. Intermediate (based on 40-foot height).

d. Hazard Classification. High.

e. Ownership. High Ridge Water Company.

f. Purpose of Dam. Water supply.

g. Design and Construction History. Tubmill Dam was designed and constructed by the American Pipe Manufacturing Company. The construction of the dam was completed in 1907.

h. Normal Operating Procedure. The reservoir is maintained at spillway level, Elevation 1326.5 (USGS Datum), leaving two feet of freeboard to the top of the dam at Elevation 1328.5. All inflow occurring when reservoir level is at the spillway crest elevation or above is discharged over the uncontrolled spillway. The supply water is taken from the 24-inch supply line.

1.3 Pertinent Data

a. Drainage Area - 10.66 square miles (Plate 2)

b. Discharge at Dam Site (cfs)

Maximum known flood at dam site - One foot over the spillway in 1936
Warm water outlet at pool elevation - N/A
Diversion tunnel low pool outlet at pool elevation - N/A
Gated spillway capacity at pool elevation - N/A
Gated spillway capacity at maximum pool elevation - N/A
Ungated spillway capacity at maximum pool elevation - 1755
Total spillway capacity at maximum pool elevation - 1755

c. Elevation (USGS Datum) (feet)

Top of dam - 1328.5
Maximum pool-design surcharge - N/A
Full flood control pond - N/A
Recreation pool - N/A
Spillway crest - 1326.5
Upstream portal invert diversion tunnel - 1286.75
Downstream portal invert diversion tunnel - Unknown

Streambed at center line of dam - 1287±
Maximum tailwater - 1290±

d. Reservoir (feet)

Length of maximum pool - 2500±
Length of recreation pool - N/A
Length of flood control pool - N/A

e. Storage (acre-feet)

Recreation pool - 614
Flood control pool - N/A
Design surcharge - 82
Top of dam - 696

f. Reservoir Surface (acres)

Top of dam - 41+
Maximum pool - 41+
Flood control pool - N/A
Recreation pool - N/A
Spillway crest - 41

g. Dam

Type - Masonry gravity
Length - 1100 feet
Height - 40 feet
Top width - 6 feet
Side slopes - 2H:3V downstream, vertical upstream
Zoning - No
Impervious core - No
Cutoff - Yes
Grout curtain - No

h. Diversion and Regulating Tunnel

Type - 30-inch-diameter cast iron
Length - 120 feet (estimate)
Closure - N/A
Access - N/A
Regulating facilities - Yes

i. Spillway

Type - Overflow section of dam
Length of weir - 200 feet
Crest elevation - 1326.5 feet
Gates - N/A

Upstream channel - Lake
Downstream channel - Natural stream

SECTION 2
ENGINEERING DATA

2.1 Design

a. Data Available

(1) Hydrology and Hydraulics. Review of the information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources (PennDER), showed that there are no original hydrology and hydraulic design data available for the dam. However, a state inspection report entitled, Report Upon the Tubmill Dam, dated October 23, 1914, states the criteria used to size the spillway.

(2) Dam. No design information is available. The 1914 inspection report includes the results of an independent stability analysis.

(3) Appurtenant Structures. No design information is available.

b. Design Features

(1) Dam. As designed, the dam is a "boulder concrete" wall faced with rubble masonry. Plate 3 illustrates the typical cross section of the dam. It consists of an essentially vertical upstream face and a two horizontal to three vertical (2:3) sloping downstream face. The crest is capped with cut stones, 6 feet long and 2 feet thick.

The drawings indicate that the dam was founded on rock.

Plate 4 illustrates the rock formations at the site. The right abutment is shown to consist of fire clay underlain by hard shale to Elevation 1275 and then sandstone. At the valley bottom, the subsurface profile shows 15 feet of sand and boulders underlain by sandstone with isolated seams of coal and fire clay. The left abutment is essentially sand and boulders underlain by shale from Elevation 1290 to valley bottom.

Plate 5 presents a plan and elevation of the dam.

(2) Appurtenant Structures. The spillway is a low section of the dam. The crest of the spillway is capped with rounded hand-cut stones, approximately 6 feet wide and 2 feet thick. The flow from the spillway discharges onto a stone-paved apron and then into a plunge pool.

c. Design Data

(1) Hydrology and Hydraulics. The 1914 inspection report states that the spillway of the dam was designed to discharge a flow of 180 cubic feet per second (cfs) per square mile of watershed, for a total flow of 1919 cfs.

(2) Dam. The 1914 inspection report states that the factor of safety of the dam against overturning ranges between 1.65 to 2.25. The high factor of safety corresponds to the assumption of no hydrostatic pressure at the base of the dam, and the lower factor of safety corresponds to hydrostatic uplift pressure of zero at the downstream toe and two-thirds of the total reservoir head at the upstream toe.

(3) Appurtenant Structures. No design data were found relative to the design of appurtenant structures except as stated above.

2.2 Construction. No information was found concerning the construction of the dam. The 1914 inspection report states that the construction of the dam was under the direction of Mr. J. W. Ledoux, the Chief Engineer of the American Pipe Manufacturing Company.

A 1924 inspection report states that in the summer of 1924 a few holes were drilled through the crest of the dam and were cement grouted to stop small seepages through the dam.

2.3 Operation. There are no formal operating records available for this dam. As designed, the dam serves as a water supply reservoir. The supply water from the reservoir discharges through a 24-inch pipe, controlled by valves located in the valve house at the downstream toe of the dam, and joins the transmission system.

The 30-inch "blow-off" pipe is also controlled by a valve in the valve house. It discharges into the stream through a channel along the right side of the valley.

2.4 Other Investigations. The available information indicated no investigations other than the periodic inspections conducted by the state.

2.5 Evaluation

a. Availability. A very limited amount of engineering data for the dam is available in PennDER files.

b. Adequacy

(1) Hydrology and Hydraulics. Available engineering data are not adequate to assess the structure. Only the design capacity of the spillway is reported.

(2) Dam. Although no original design data are available, the 1914 inspection report includes the results of an independent stability analysis which considered the stability of the structure against overturning with and without hydrostatic uplift pressure. Although the reported analysis procedure appears to be satisfactory in general, the calculations were not available for review.

The regional geology of the dam site was reviewed (Appendix E) and no features were found that would significantly affect the performance of this structure.

(3) Appurtenant Structures. The flow from the "blow-off" and supply lines through the dam are controlled by valves located at the downstream side of the dam. Therefore, these pipes are always under pressure through the dam. However, this design feature is not considered to be a deficiency for masonry or concrete dams.

c. Operating Records. To the best knowledge of the water company personnel, no operating difficulties have been encountered in the recent past. A state inspection report dated May 14, 1936, states that during the flood in March 1936 the maximum flow over the spillway was 0.96 foot.

d. Post-Construction Changes. There have been no reported significant modifications to the original dam design. However, an outlet riser pipe was constructed in 1962, as shown on Plate 6.

e. Seismic Stability. The dam is located in Seismic Zone 1 and static stability of the dam is considered to be adequate. Therefore, based on the recommended criteria for evaluation of seismic stability of dams, the structure is assumed to present no hazard from earthquake.

SECTION 3
VISUAL INSPECTION

3.1 Findings

a. General. The on-site inspection of Tubmill Dam consisted of:

1. Visual inspection of the retaining structure, abutments, and toe.

2. Visual examination of the spillway and its components, the downstream end of the outlet pipe, and other appurtenant features.

3. Observation of factors affecting the runoff potential of the drainage basin.

4. Evaluation of the downstream area hazard potential.

The specific observations are illustrated in Plate 7 and in the photographs in Appendix C.

b. Dam. The general inspection of the retaining structure consisted of searching for indications of structural distress, such as cracks and deterioration of rock surfaces, seepage areas, and observing general maintenance conditions and other surficial features.

1. The entire downstream face of the dam was found to be wet. The seeps appeared to be coming from near the top of the dam. No concentrated seeps were observed.

2. Wet areas were observed both on the right and left abutments along the toe of the dam. A sewer pipe discharging along the left abutment toe appeared to be contributing significantly to the wetness on that side. No flow away from the wet areas was found.

3. Two wet areas and one concentrated seepage area was found on the right abutment approximately 150 feet downstream from the dam. One wet area was located on a terrace on the right abutment, but no water was

discharging from this area. The second wet area was located at the toe level of the dam along the right valley wall, and the discharge collected from this area was flowing into the outlet pipe discharge channel through a 6-inch pipe. The amount of flow was estimated to be approximately one to two gallons per minute. The concentrated seepage area was located along the right bank of the outlet pipe discharge channel 250 feet downstream from the dam. The total flow from this area was estimated to be one cubic foot per second (cfs).

4. Numerous grout holes were observed on the crest of the dam. The appearance of the grout material suggests that the grouting was done at various times in the past.

c. Appurtenant Structures. The spillway crests and plunge pools were examined for deterioration or other signs of distress and obstructions that would limit flow. No signs of apparent distress or erosion were observed.

d. Reservoir Area. The watershed is predominantly covered with woodlands and infiltration capacity is estimated to be good. There appeared to be no major land clearing activities or other operations that would significantly increase the runoff rate of the drainage basin. The shorelines are not considered to be susceptible to massive landslides which would affect the storage volume of the reservoir or cause overtopping of the dam by displaced water.

e. Downstream Channel. Tubmill Creek, for most of its course, flows through a meandering streambed. Sketches of the bridges over the stream in the first three-mile reach from the dam are included in Appendix A. Photograph 11 shows the stream along Route 711. The bridge on Route 711 over Tubmill Creek is shown in Photograph 12. The downstream channel was described in Section 1.2.

3.2 Evaluation. In general, the condition of the dam is considered to be good. As far as can be assessed from the downstream end, the condition of the outlet pipe also appears to be good.

SECTION 4
OPERATIONAL FEATURES

4.1 Procedures. A review of the design drawings and field observations indicates that there are no formal procedures for operating the dam. The only operational feature of the dam which may affect the safety of the dam is the outlet pipe valve, in case it is required to lower the reservoir.

Clearing of debris from the spillway as it is required and continued inspection of the facilities by the dam tender are the principal maintenance operations which would affect safety.

4.2 Maintenance of the Dam. The overall maintenance conditions of the dam appear satisfactory.

4.3 Maintenance of Operating Facilities. On the date of the field inspection, the blow-off pipe was operated by the water company personnel and was observed to be functional.

4.4 Warning System in Effect. There is no formal warning system in effect. The dam tender resides at the site, and telephone communication facilities are available.

4.5 Evaluation. The dam is satisfactorily maintained, and it is considered to be reasonably accessible under all weather conditions for inspection and emergency action purposes.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features. No formal hydrology and hydraulic calculations are available for this dam.

a. Design Data. Tubmill Dam has a watershed area of 10.66 square miles and impounds a reservoir with a surface area of 41 acres. A 200-foot-wide spillway flowing over the dam constitutes the flood discharge system for the impoundment. The flow through the spillway is controlled by a 6-foot-wide stone weir at an elevation 2 feet below the crest of the dam. As it presently exists, the spillway has a maximum discharge capacity of approximately 1755 cfs with no freeboard.

b. Experience Data. As previously stated, Tubmill Dam is classified to be an "intermediate" size dam in the "high" hazard category. Under the recommended criteria for evaluating emergency spillway discharge capacity, such impoundments are required to pass the probable maximum flood (PMF).

The adequacy of the spillway was analyzed based on the simplified procedure developed by the Baltimore District Corps of Engineers (Appendix D). Based on this analysis procedure, it was determined that the PMF inflow hydrograph would have a peak of 15,990 cfs and a total volume of approximately 14,800 acre-feet. These values are greater than the spillway capacity (1755 cfs) and the reservoir flood storage volume (82 acre-feet). Therefore, the spillway is not capable of passing the PMF flow without overtopping. Further analysis, according to the procedure, indicated that the spillway can pass a maximum flow of approximately 11 percent of the PMF without overtopping. In the event of full PMF, the depth of overtopping was determined to be approximately 2.4 feet.

c. Visual Observations. On the date of inspection, no conditions were observed which would indicate that the spillway of the dam could not operate satisfactorily in the event of a flood.

d. Overtopping Potential. As stated above, the dam will be overtopped during a flood whose magnitude exceeds 12 percent PMF. However, because it is a masonry dam, overtopping is not considered to significantly affect the overall stability of the dam.

e. Spillway Adequacy. Based on the observations stated above, flood discharge capacity of the dam is considered to be adequate.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. As discussed in Section 3, the field observations did not reveal any signs of distress that would significantly affect the stability of the dam and none were reported in the past.

b. Design and Construction Data. It appears that the original design incorporated stability analysis for the dam. Visual observations and past inspection reports indicate that the structure was constructed with reasonable care.

As part of this inspection, the stability of the dam was reevaluated by an independent preliminary analysis (Appendix D). The preliminary stability analysis indicated that the factor of safety against overturning is 1.3 when pool level is at the crest level of the dam and 1.1 when the dam is overtopped by 2-1/2 feet. Sliding shear stresses for the two loading conditions were determined to be 21 psi and 24 psi, respectively. The sliding shear stresses are within the range of allowable shear strength of sandstones typical to the area on which the dam is reported to be founded. This analysis indicates that the dam is stable, concurring with the results of an analysis noted in the 1914 inspection report.

c. Operating Records. The structural stability of the dam is not considered to be affected by the operational features of the dam.

d. Post-Construction Changes. There have been no reported modifications to the original design that would affect the structural stability of the structure. However, Plate 6 presents an outlet riser pipe that was constructed in 1962.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment

a. Safety. The visual observations and review of available information indicate that the Tubmill Dam is in good condition. It appears that the structure was built and has been maintained with reasonable care. The capacity of the spillway was found to be "inadequate" (11 percent PMF) relative to the spillway capacity criteria established by the Corps of Engineers. However, because overtopping would not cause failure of the dam, flood discharge capacity of the dam was considered to be adequate.

b. Adequacy of Information. Although the available design information is very limited, a reasonable assessment of the dam can be made based on visual observations, reports of past observations, and previous experience of inspectors.

c. Urgency. It is considered that the recommendations suggested below be implemented on a continuing basis.

d. Necessity for Further Investigation. The condition of the dam does not require more detailed investigation at this time.

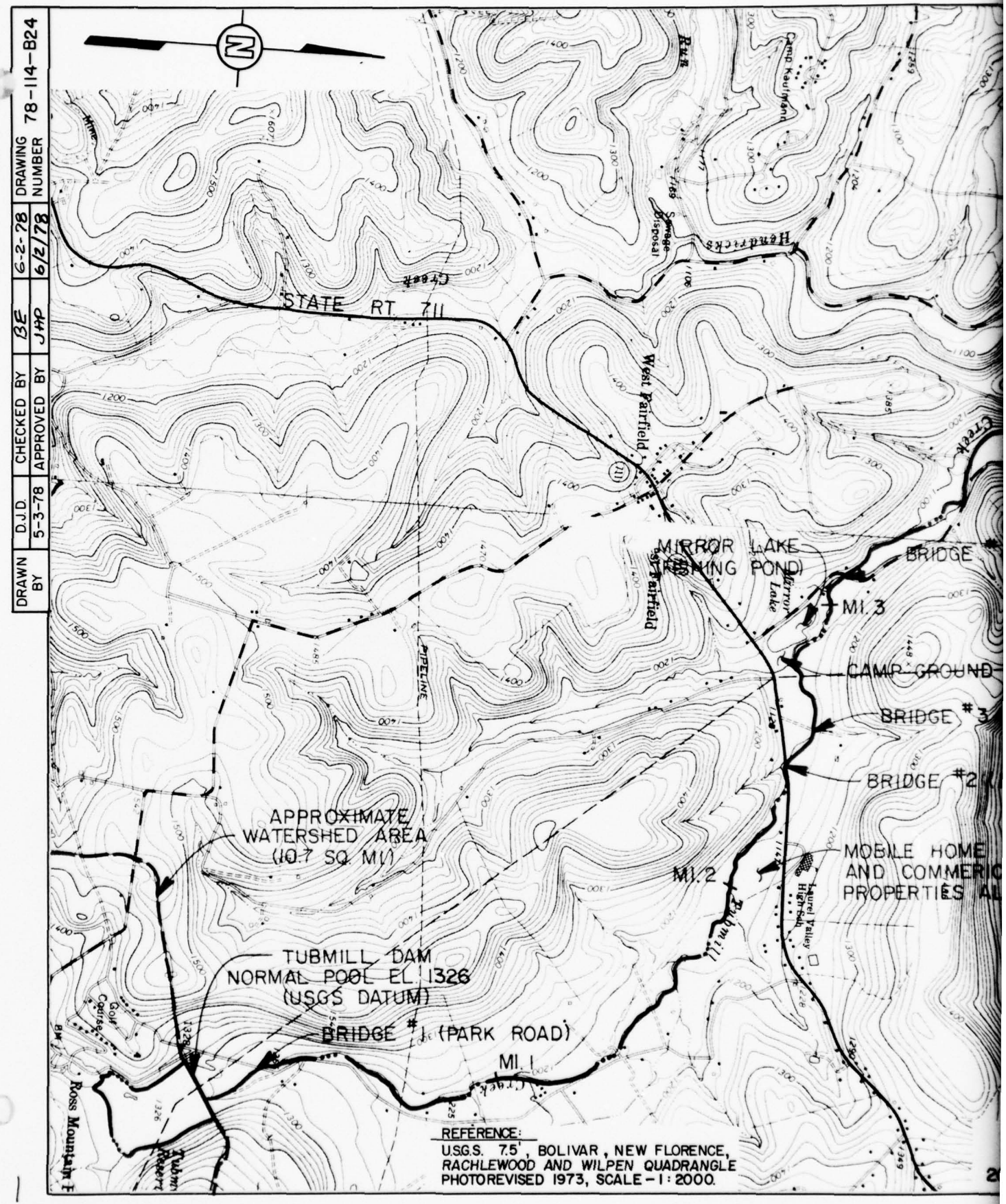
7.2 Recommendations/Remedial Measures

1. Since the dam may overtop during unusually high runoff, it is recommended that during such periods the owner should provide around-the-clock surveillance for early detection of problems, such as erosion of the abutments.

2. It is recommended that the owner develop a formal warning system to alert downstream inhabitants in the event of emergency.

3. It is recommended that the owner be advised that the dam and appurtenant structures should be inspected regularly and any unusual conditions should be reported to the appropriate authorities.

PLATES


DRAWN BY
D.J.D. 5-3-78
CHECKED BY BE 6-2-78
APPROVED BY JMP 6/2/78
DRAWING NUMBER 78-114-B24
N
STATE RT. 711
West Fairfield
Sewage Disposal
Camp Kaufmann
Hendricks
MIRROR LAKE (FISHING POND)
BRIDGE
MI. 3
CAMP GROUND
BRIDGE #3
BRIDGE #2
APPROXIMATE WATERSHED AREA (10.7 SQ. MI.)
MI. 2
MOBILE HOME AND COMMERIC PROPERTIES AL
Laurel Valley High Sch
TUBMILL DAM
NORMAL POOL EL. 1326
(USGS DATUM)
BRIDGE #1 (PARK ROAD)
MI. 1
Golf Course
Ross Mountain
Tubmill Creek
REFERENCE:
U.S.G.S. 7.5', BOLIVAR, NEW FLORENCE, RACHLEWOOD AND WILPEN QUADRANGLE
PHOTOREVISED 1973, SCALE - 1:2000.

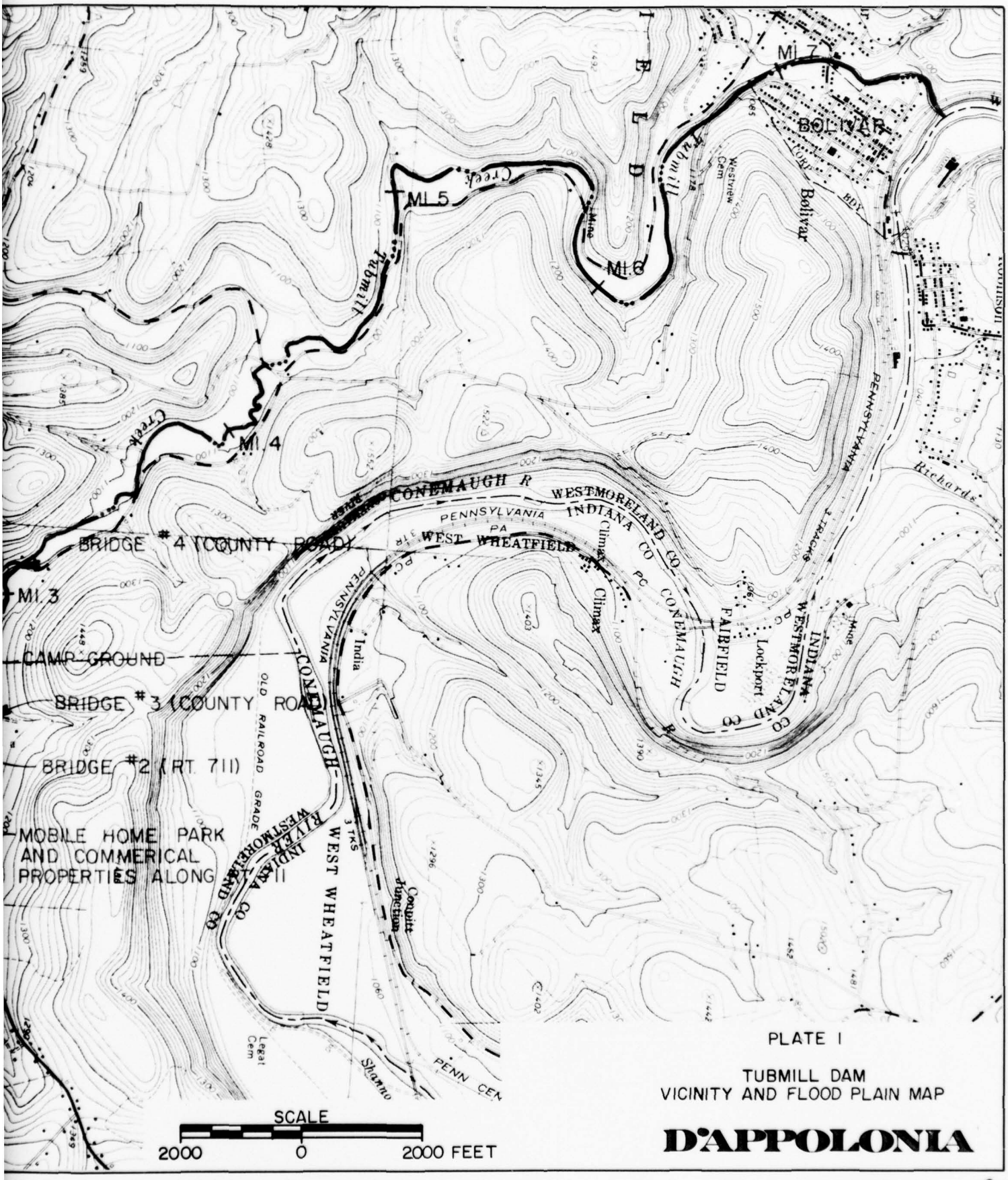
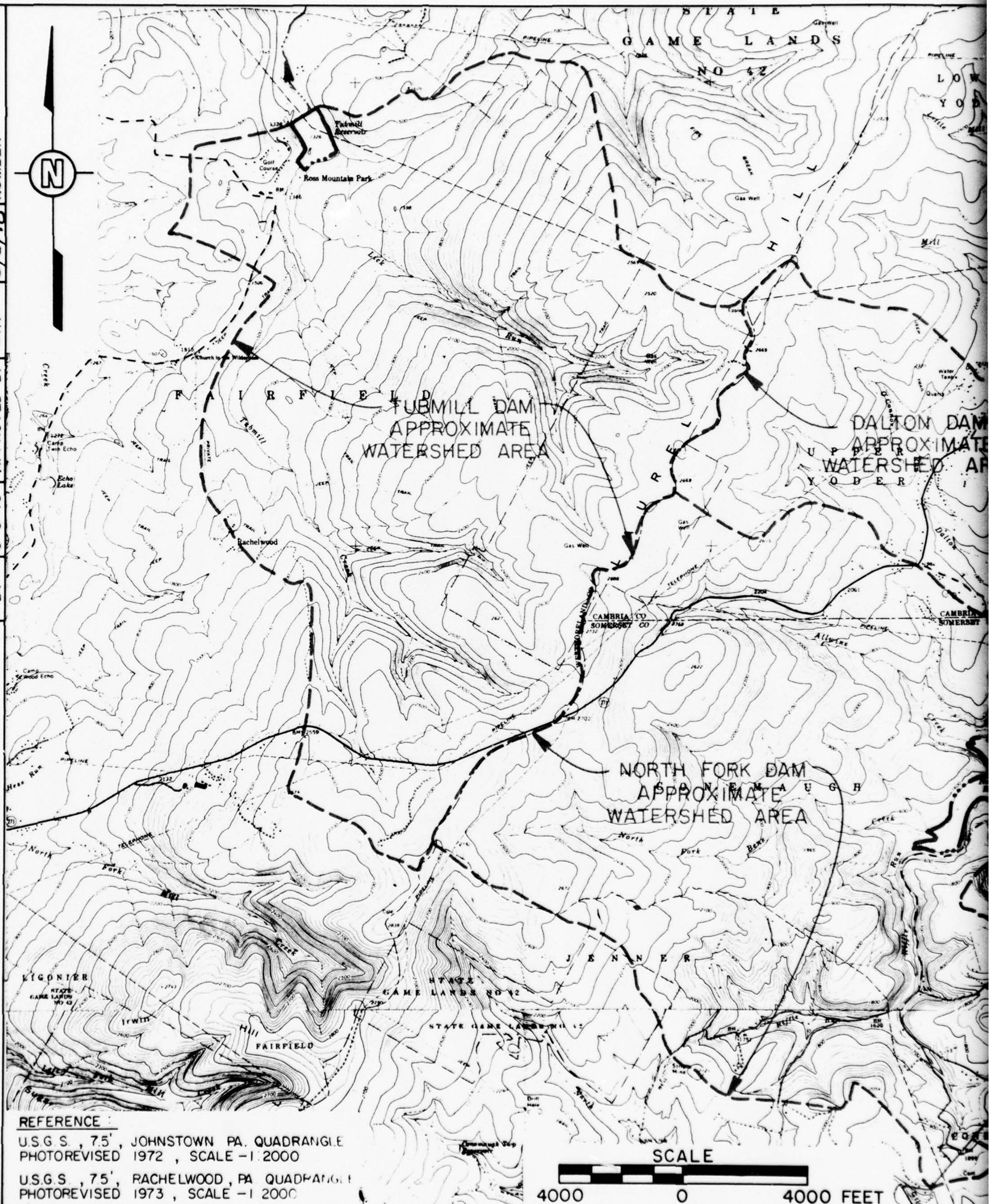


PLATE I

TUBMILL DAM
VICINITY AND FLOOD PLAIN MAP

D'APPOLONIA



REFERENCE :

U.S.G.S. , 7.5', JOHNSTOWN PA. QUADRANGLE
PHOTOREVISED 1972 , SCALE - 1:2000

U.S.G.S. , 7.5', RACHELWOOD , PA QUADRANGLE
PHOTOREVISED 1973 , SCALE - 1:2000

DRAWN BY	DJD	CHECKED BY	BE	6-2-78	DRAWING NUMBER 78-114-B25
	5-3-78	APPROVED BY	JHP	6/2/78	

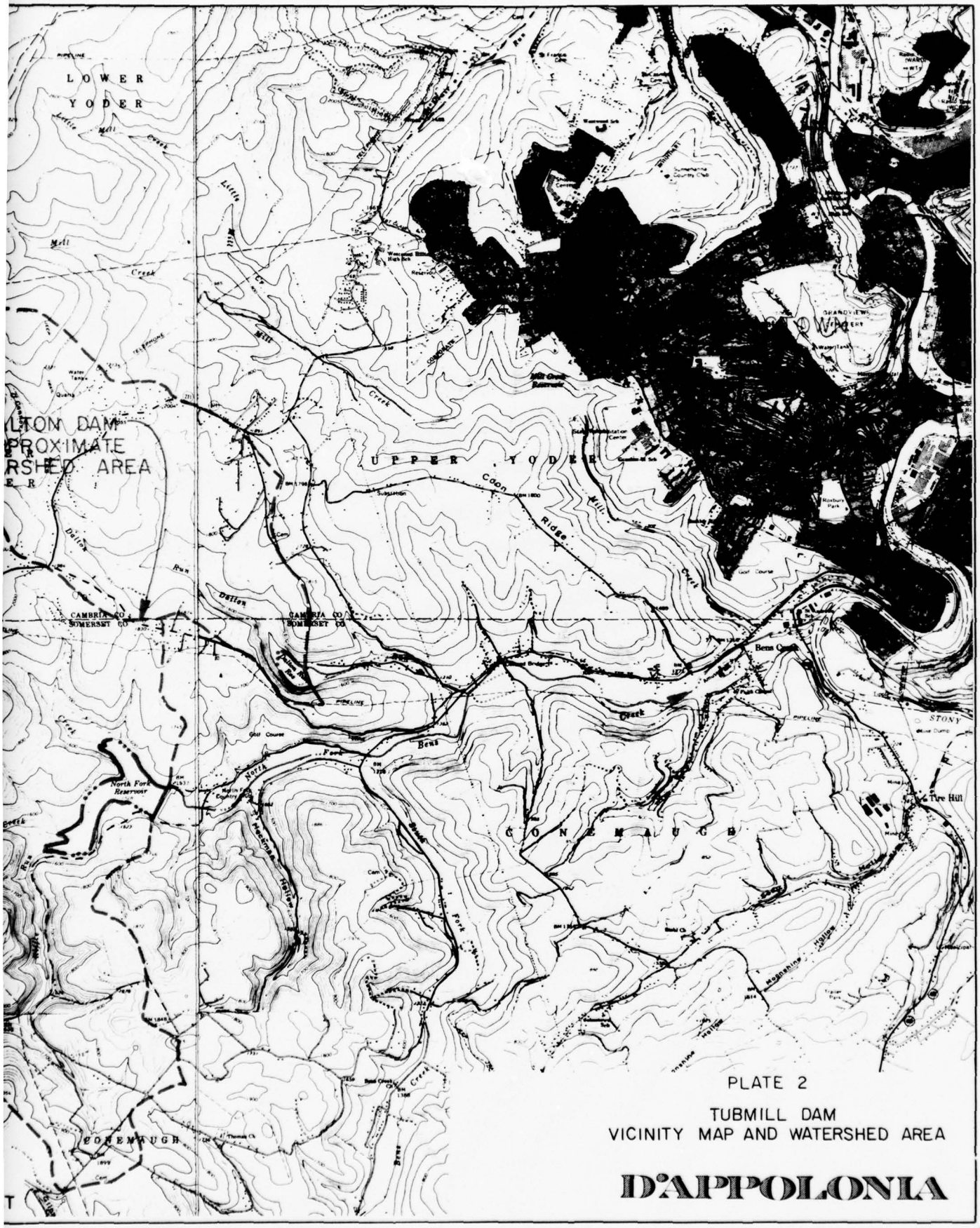
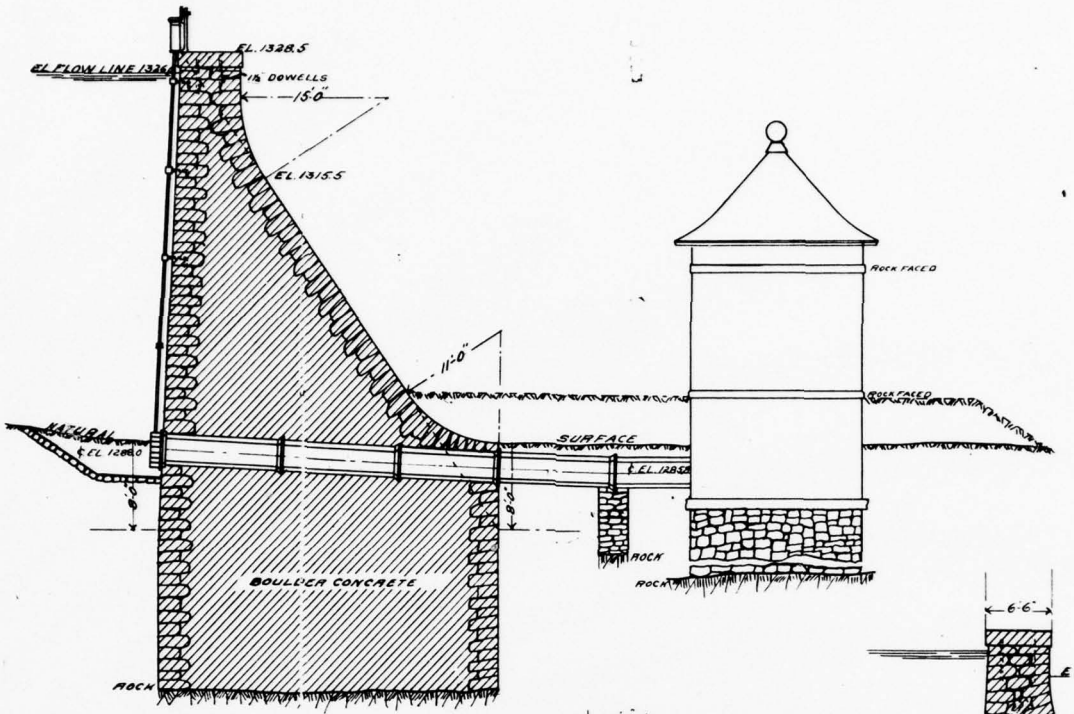


PLATE 2

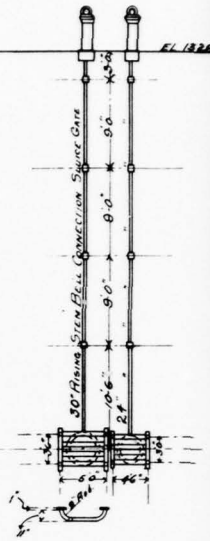
TUBMILL DAM
VICINITY MAP AND WATERSHED AREA

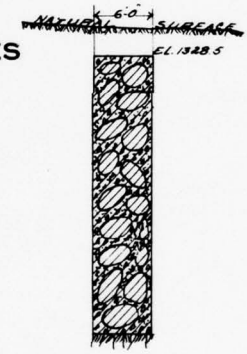
D'APPOLONIA

DRAWN BY	D.J.D.	CHECKED BY	BE	6-2-78	DRAWING NUMBER	78-114-B27
	5-2-78	APPROVED BY	JHD	6/2/78		

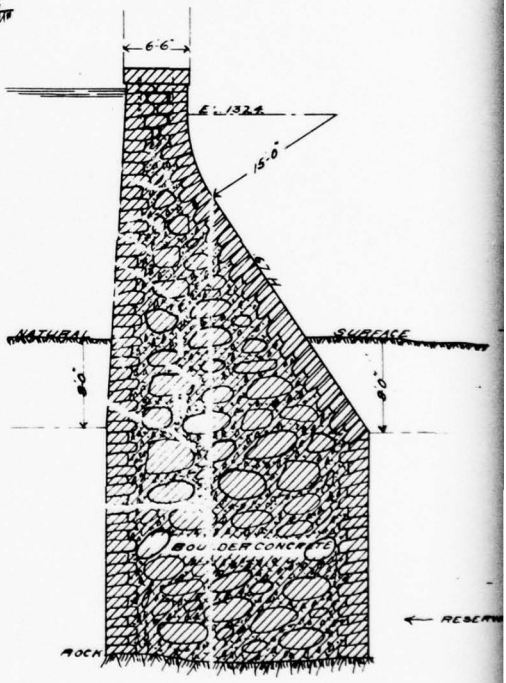


SECTION THROUGH PIPES





SECTION B-B

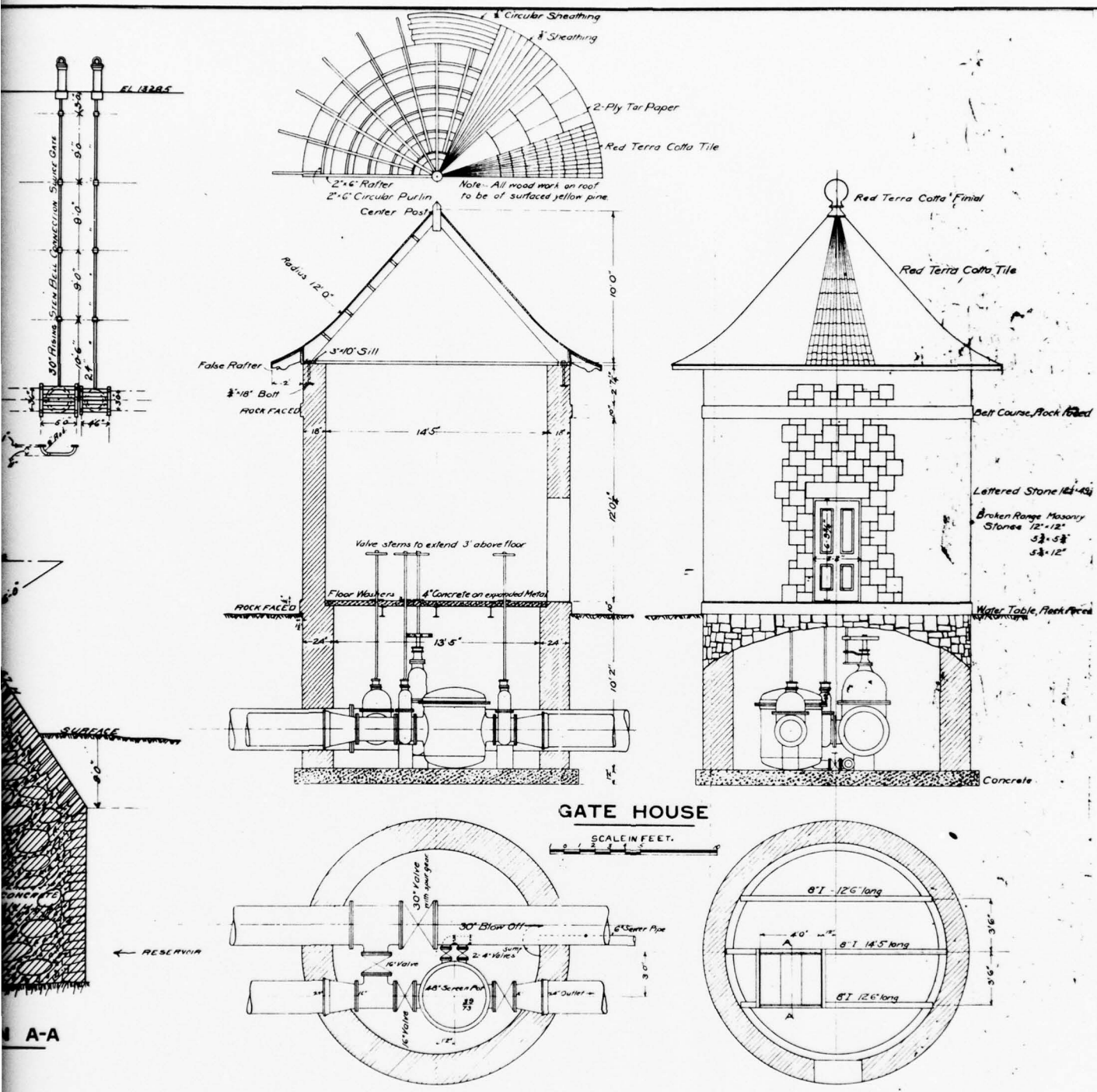


SECTION A-A

SECTION THROUGH SPILLWAY

SCALE IN FEET

Chief Engineer, The American Pipe Mfg. Co.



GATE HOUSE

SCALE IN FEET.

HIGH RIDGE WATER SUPPLY CO.

DETAILS OF DAM & GATE HOUSE
TUB MILL STORAGE RESERVOIR

ST CLAIR TWP., WESTMORELAND CO., PA.

CAPACITY 200 000 000 GALS.

THE AMERICAN PIPE MFG. CO.
ENGINEERS & CONTRACTORS.
112 N. BROAD ST., PHILA., PA.

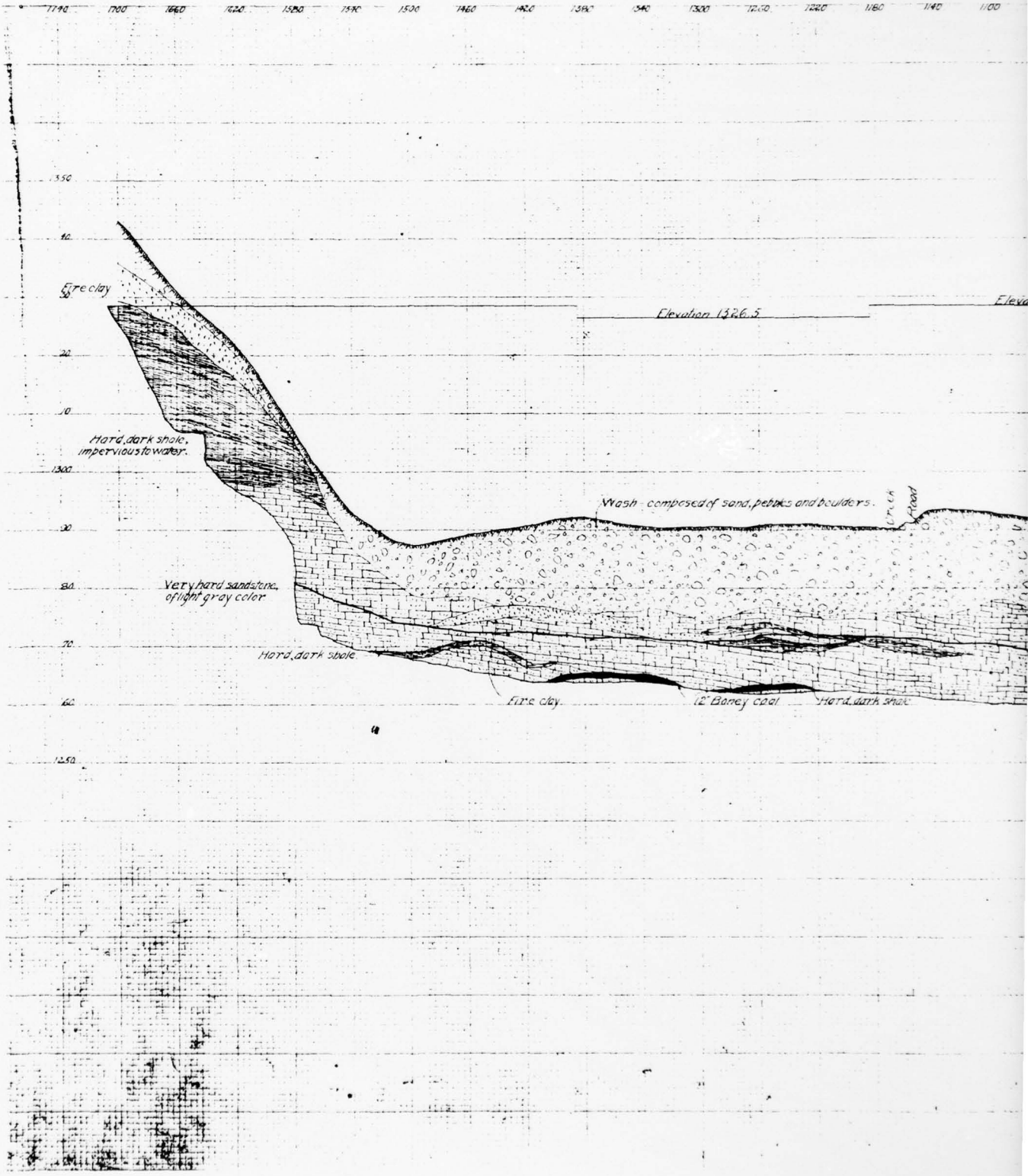
PLATE 3

D'APPOLONIA

APPROVED
Chief Engineer, H. of W., P. R. R. Co.
190

2

DRAWN BY	D.J.D.	CHECKED BY	BE	6-2-78	DRAWING NUMBER	78-114-B28
	5-3-78	APPROVED BY	JHP	6/12/78		



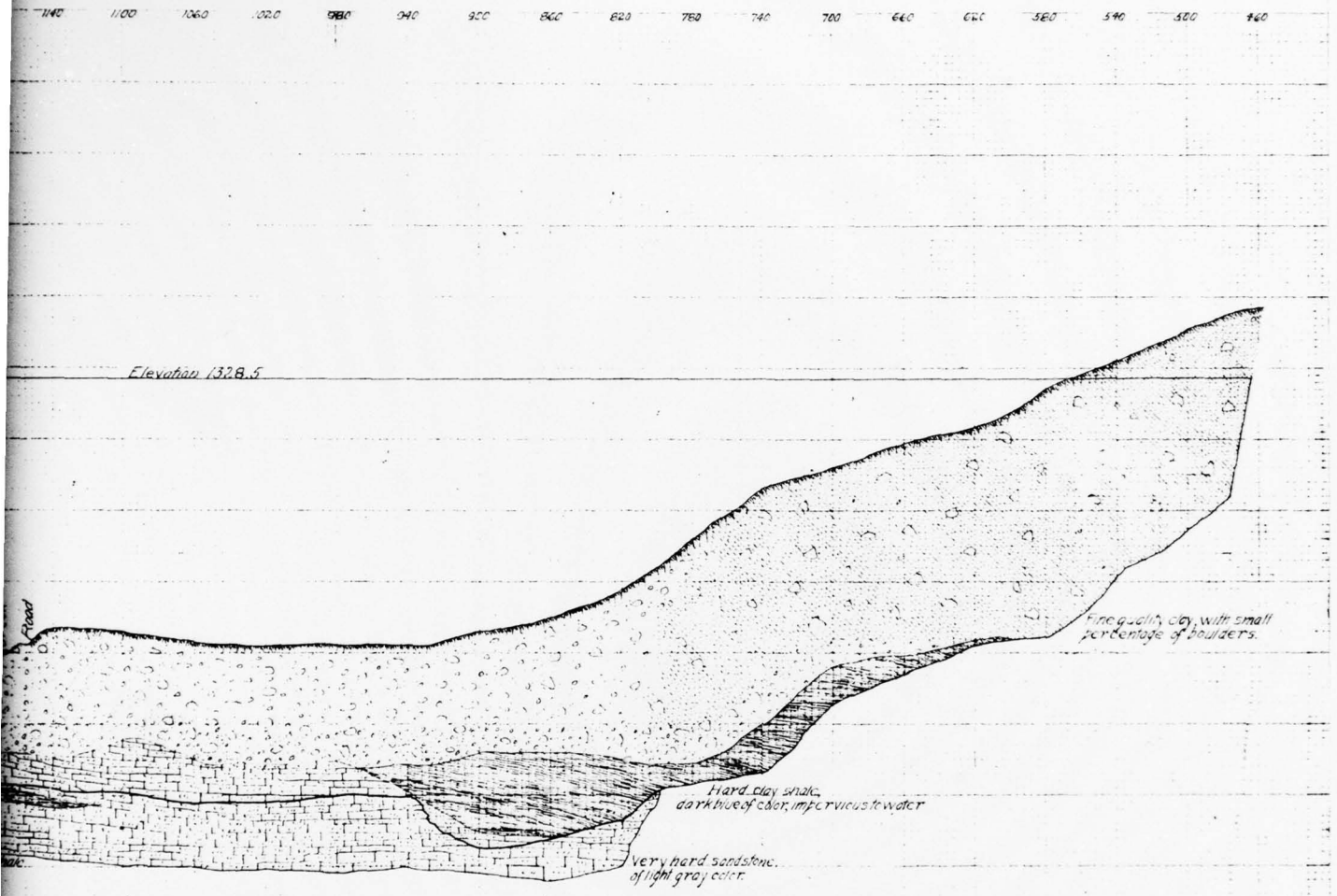
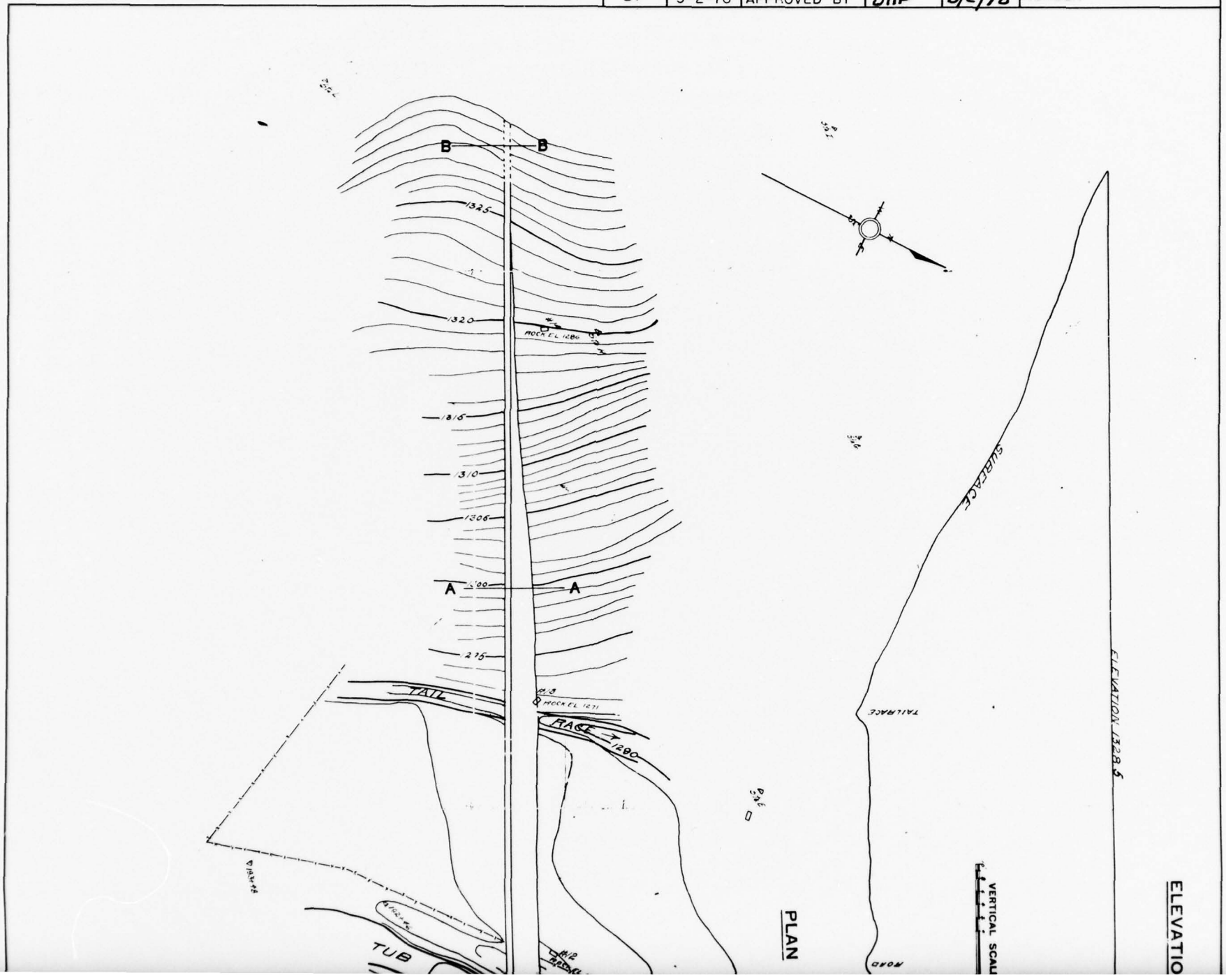


PLATE 4

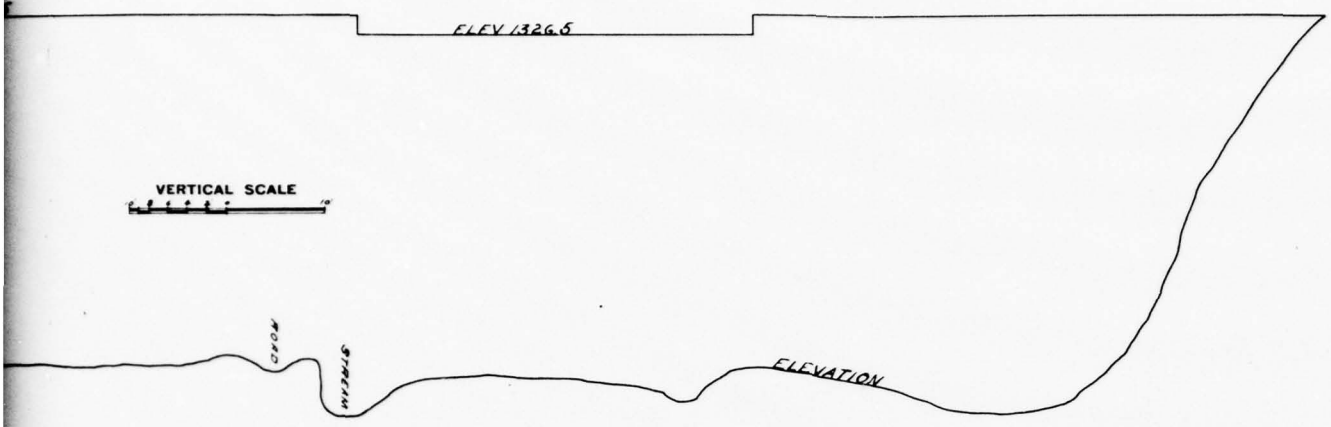
D'APPOLONIA

2

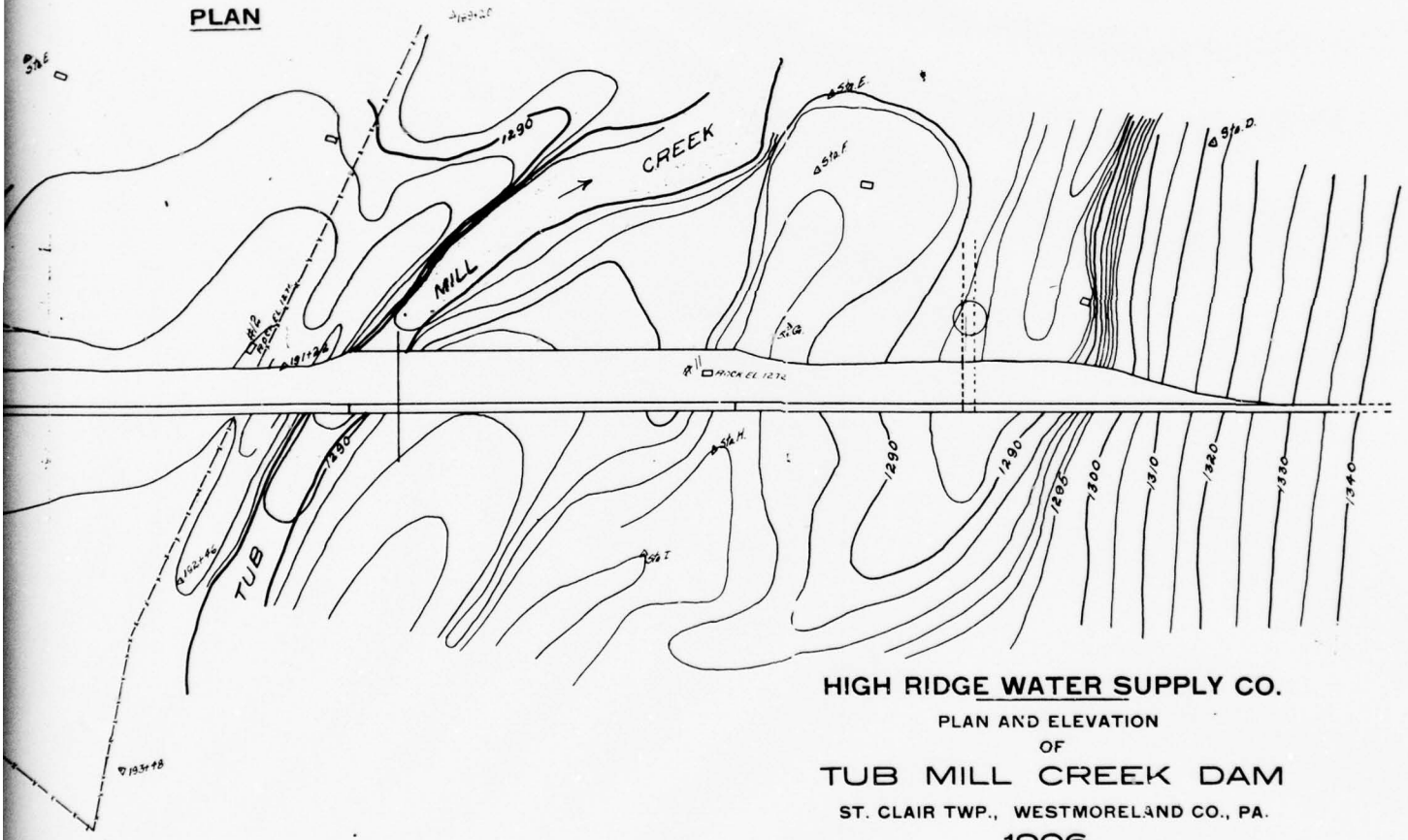
DRAWN BY	D.J.D.	CHECKED BY	BE	6-2-78	DRAWING NUMBER	78-114-B26
	5-2-78	APPROVED BY	JHP	6/2/78		



ELEVATION



PLAN



HIGH RIDGE WATER SUPPLY CO.

PLAN AND ELEVATION

OF

TUB MILL CREEK DAM

ST. CLAIR TWP., WESTMORELAND CO., PA.

1906.

SCALE: 1"=40'

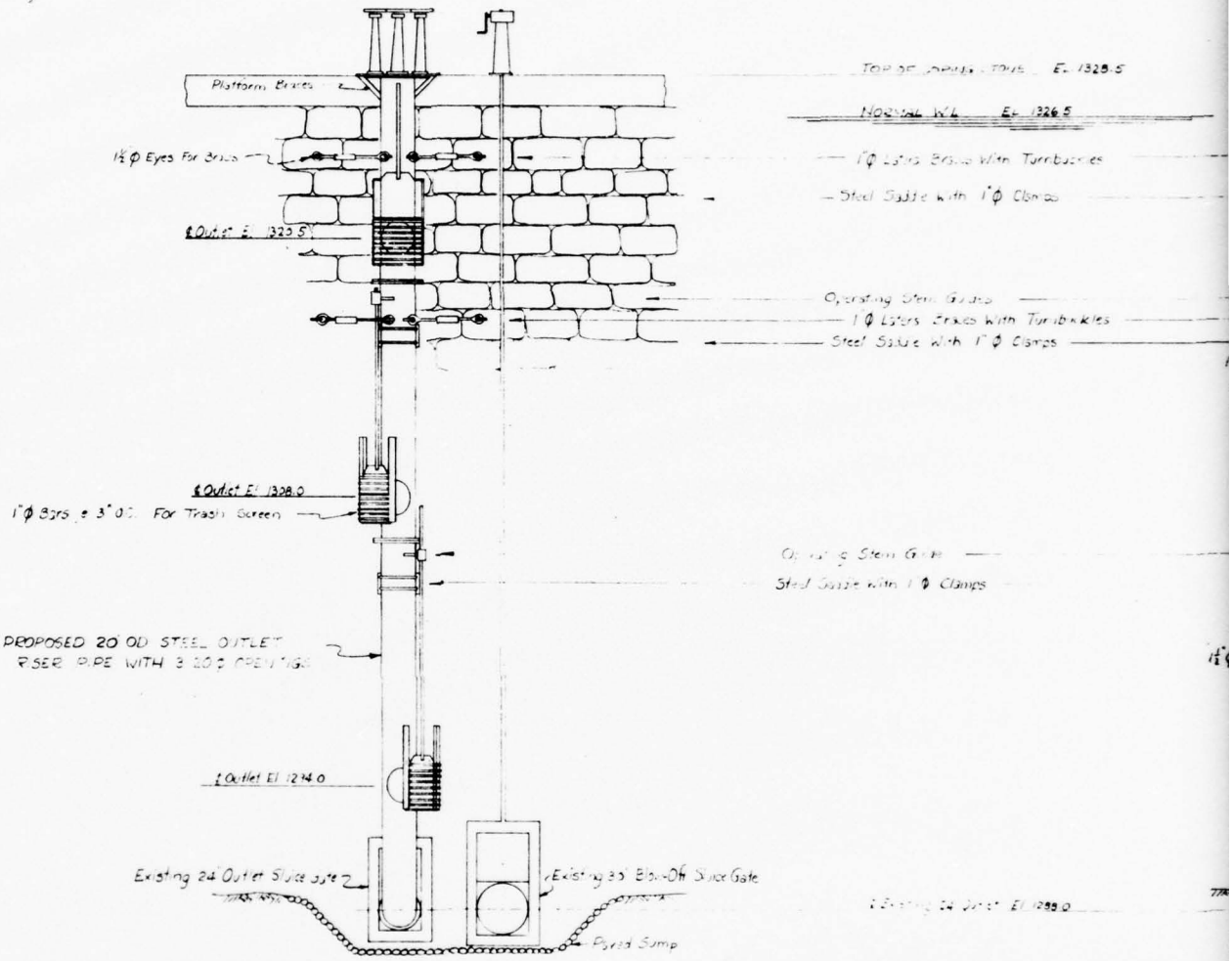
10' 0 50 100 150'

THE AMERICAN PIPE MFG. CO.
ENGINEERS & CONTRACTORS
112 S. BROAD ST., PHILA., PA.

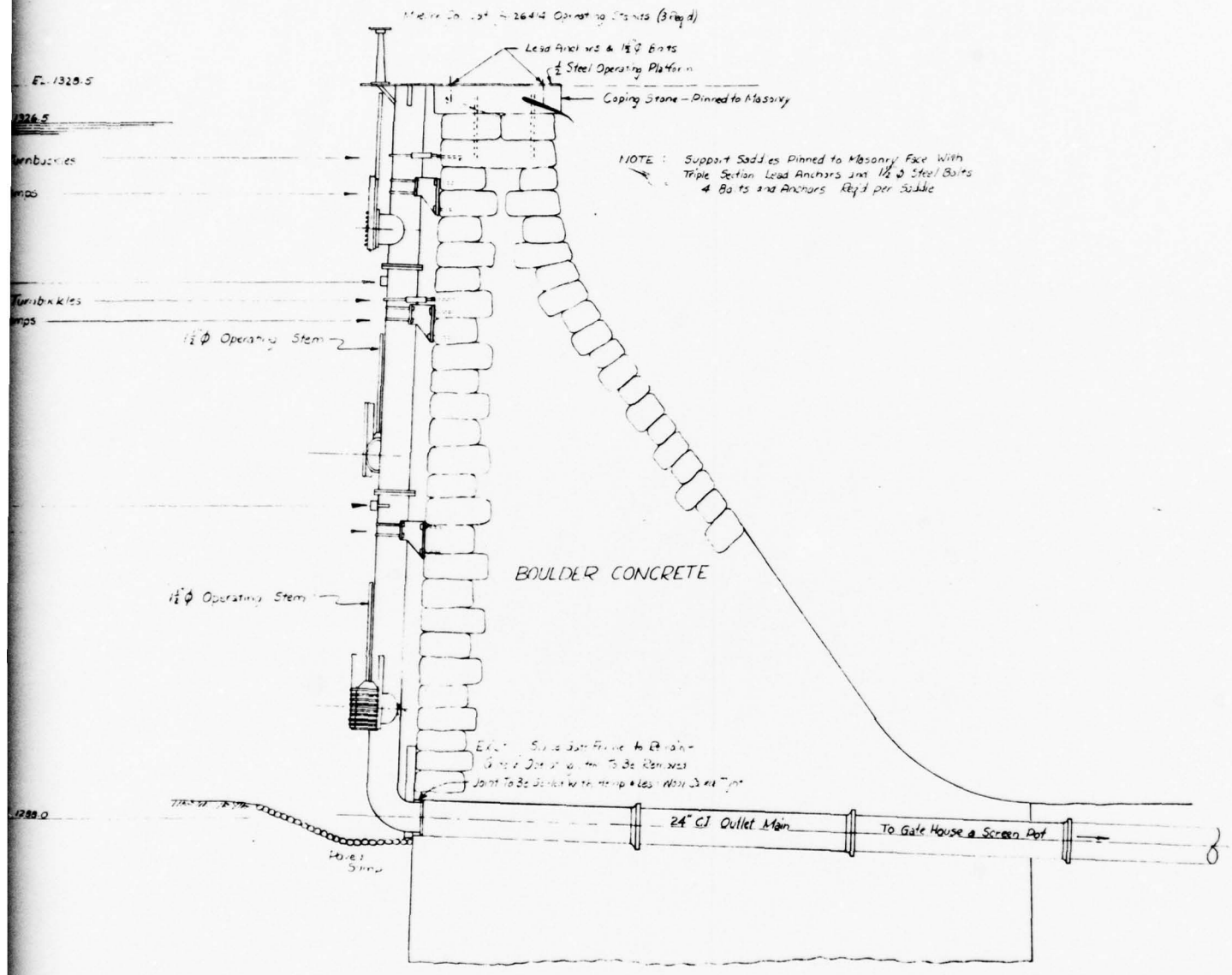
PLATE 5

D'APPOLONIA

DRAWN BY	D.J.D.	CHECKED BY	RE	6-2-78	DRAWING NUMBER	78-114-B29
	5-2-78	APPROVED BY	JHP	6/2/78		



ELEVATION - LOOKING DOWNSTREAM



SECTION THROUGH DAM AT OUTLET PIPE

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
RICHARD C. RABOLD
ENGINEER

HIGH RIDGE WATER SUPPLY COMPANY

PROPOSED OUTLET RISER PIPE
TUB MILL DAM

NEAR NEW FLORENCE, PA.

SCALE : ¼" = 1'-5" RCR MARCH 1961

PLATE 6

D'APPOLONIA

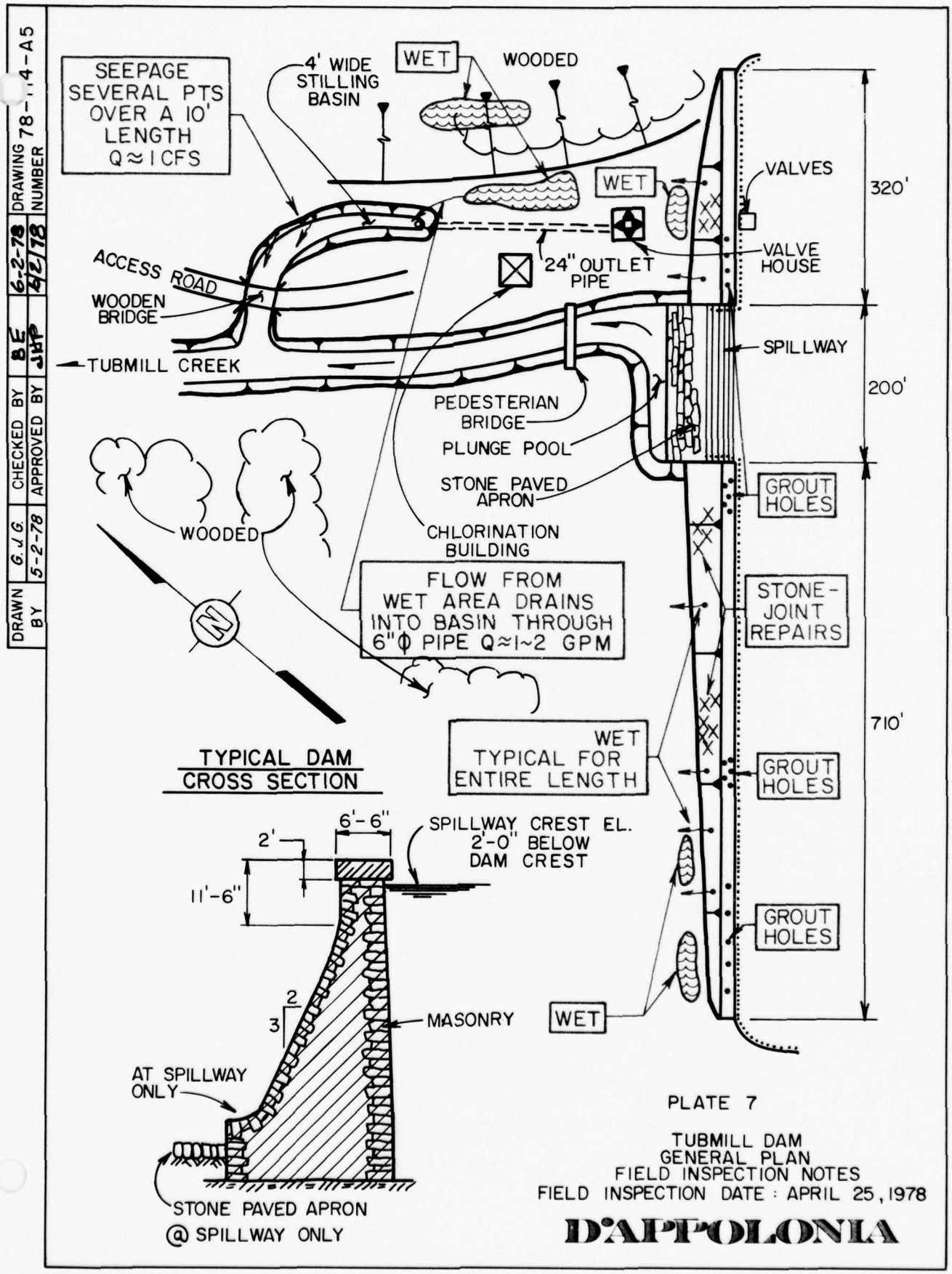


PLATE 7

TUBMILL DAM
GENERAL PLAN
FIELD INSPECTION NOTES
FIELD INSPECTION DATE : APRIL 25, 1978

D'APPOLONIA

APPENDIX A

CHECKLIST, VISUAL INSPECTION
PHASE I

CHECKLIST
VISUAL INSPECTION
PHASE I

NAME OF DAM TUBMILL DAM COUNTY WESTMORELAND STATE PA. ID# NDS: 488, DER: 65-1

TYPE OF DAM MASONRY HAZARD CATEGORY HIGH

DATE(S) INSPECTION 4/25/78 WEATHER SUNNY TEMPERATURE 50's

POOL ELEVATION AT TIME OF INSPECTION 1326 M.S.L. TAILWATER AT TIME OF INSPECTION ~1286 M.S.L.

INSPECTION PERSONNEL:

B. EREL
W. T. CHAN

REVIEW INSPECTION BY: (5-4-78)

ELIO D'APPOLONIA
LAWRENCE ANDERSEN
JAMES POELLOT.

BILGIN EREL RECORDER

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM TOBMILL DAM
ID# NDS: 488 DER: 65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	(MASONRY DAM) ∴ N/A.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	N/A	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	N/A	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	N/A	
RIPRAP FAILURES	N/A	

VISUAL INSPECTION
PHASE I
EMBANKMENT

NAME OF DAM TUBMILL DAM

ID# NDS:488, DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	(MASONRY DAM) ∴ N/A.	
ANY NOTICEABLE SEEPAGE	∴ N/A.	
STAGE GAGE AND RECORDER	NONE	
DRAINS	NONE.	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM TUBMILL DAM
ID# NDS:488 DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	DOWNSTREAM FACE OF THE DAM WET (NO MEASURABLE SEEPAGE)	(SEE PLATE-5)
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	NO VISUAL SIGNS OF DISTRESS NO SEEPAGE.	
DRAINS	NONE FOUND.	
WATER PASSAGES	NONE	
FOUNDATION	NO PERCEIVABLE SIGN OF DISTRESS.	

VISUAL INSPECTION
PHASE I
CONCRETE/MASONRY DAMS

NAME OF DAM TUBMILL DAM
ID# NJS:488, DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	NONE SIGNIFICANT	
STRUCTURAL CRACKING	NONE SIGNIFICANT	
VERTICAL AND HORIZONTAL ALIGNMENT	NO PERCEIVABLE MISALIGNMENT	
MONOLITH JOINTS	MASONRY DAM ∴ N/A	
CONSTRUCTION JOINTS STAFF GAGE OF RECORDER:	(NO CONSTRUCTION JOINTS) NONE FOUND	

VISUAL INSPECTION
PHASE I
OUTLET WORKS

NAME OF DAM TUBMILL DAM

ID# NDS:488 DER: 65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	OUTLET CONDUIT IS CAST IRON (24" ϕ) (ONLY OUTLET END VISIBLE)	∴ OVERALL CONDITION OF THE OUTLET CONDUIT NOT ASSESSABLE
INTAKE STRUCTURE	SUBMERGED . NOT VISIBLE.	
OUTLET STRUCTURE	NO OUTLET STRUCTURE . OUTLET PIPE DIRECTLY DISCHARGES TO OUTLET CHANNEL.	
OUTLET CHANNEL	APPROXIMATELY 4-FT WIDE (AT THE BASE) 2-FT DEEP . SIDES STONE PAVED FOR A LENGTH OF ~ 30 FT . REST NATURAL STREAM CHANNEL.	
EMERGENCY GATE	"BLOW-OFF" VALVE OPERATED, ON DATE OF INSPECTION , FOUND TO BE FUNCTIONAL.	

VISUAL INSPECTION
PHASE I
UNGATED SPILLWAY

NAME OF DAM TUBMILL DAM
ID# NDS:488 DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	STONE WEIR - GOOD CONDITION.	(SEE PLATE-7)
APPROACH CHANNEL	NONE	
DISCHARGE CHANNEL	NONE. SPILLWAY DISCHARGES INTO A PARTIALLY STONE PAVED APRON.	(SEE PLATE.7)
BRIDGE AND PIERS	NONE	

VISUAL INSPECTION
PHASE I
GATED SPILLWAY

NAME OF DAM TUBMILL DAM
ID# NDS:488, DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	(NO GATED SPILLWAY) ∴ N/A	
APPROACH CHANNEL	N/A.	
DISCHARGE CHANNEL	N/A.	
BRIDGE PIERS	N/A.	
GATES AND OPERATION EQUIPMENT	N/A	

VISUAL INSPECTION
PHASE I
INSTRUMENTATION

NAME OF DAM TUBMILL DAM

ID# NDS: 488 DER: 65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	NONE FOUND	
OBSERVATION WELLS	NONE FOUND	
WEIRS	ONE (NON FUNCTIONAL) RECTANGULAR SHARP CRESTED WEIR (~6"x12") AT THE DOWNSTREAM	SEE PLATE . 1
PIEZOMETERS	NONE FOUND	
OTHER	NONE.	

VISUAL INSPECTION
PHASE I
RESERVOIR

NAME OF DAM TUBMILL DAM
ID# NDS:488 DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	GENTLE TO STEEP - WOODED.	
SEDIMENTATION	LAKE WATER WAS CLEAR NO INDICATION OF EXCESSIVE SEDIMENTATION RATE.	

VISUAL INSPECTION
PHASE I
DOWNSTREAM CHANNEL

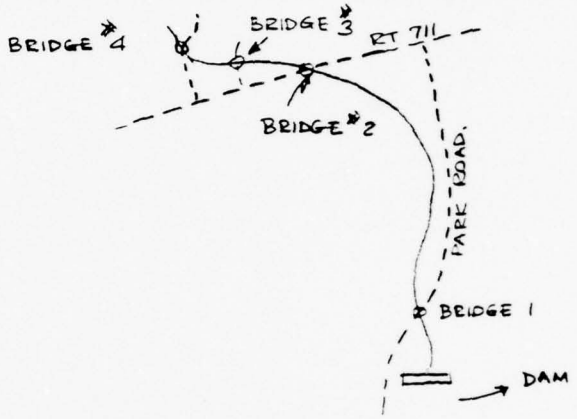
NAME OF DAM TUBMILL DAM
ID# NDS:488 DER:65-1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	TYPICAL MOUNTAIN STREAM (OCCASIONAL FALLEN TREES ETC) NO MAJOR OBSTRUCTIONS.	SEE SKETCH IN APPENDIX-A FOR SKETCHES OF BRIDGES OVER THE STREAM
SLOPES	NO MAJOR EROSION.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	APPROXIMATELY 20 HOME, ONE MOBILE HOME PARK POPULATION ≈ 120 STREAM CROSS STATE HIGHWAY 711.	SEE PLATE-1 : VICINITY AND FLOOD PLAIN MAP.

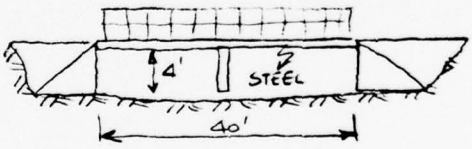
D'APPOLONIA
CONSULTING ENGINEERS, INC

By BE Date 4-25-78 Subject TUBMILL DAM DER ID: 65-1 Sheet No 1 of 1
Chkd. By WC Date 4-25-78 FIELD INSPECTION SKETCH. Proj No 78-114-05

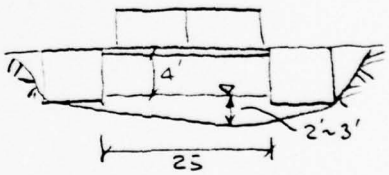
STREAM CROSS-SECTIONS @ BRIDGE LOCATIONS.



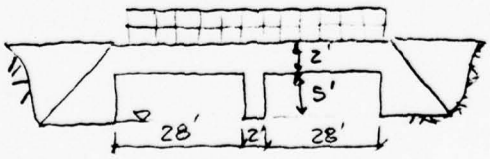
BRIDGE # 1



BRIDGE # 3



BRIDGE # 2



BRIDGE # 4

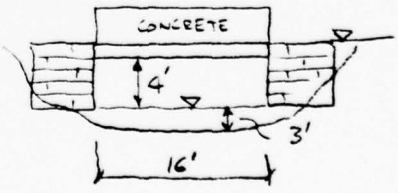


PLATE 3 : FIELD INSPECTION SKETCH

APPENDIX B

CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION PHASE I

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM TURMILL DAM
ID# NDS: 488 DER: 65-1

ITEM	REMARKS
AS-BUILT DRAWINGS	SOME DESIGN DRAWINGS AVAILABLE (NOT MARKED AS BUILT)
REGIONAL VICINITY MAP	SEE PLATE - 1
CONSTRUCTION HISTORY	PARTIALLY DOCUMENTED IN STATE INSPECTION REPORT DATED OCTOBER 23, 1914 BUILT : 1907
TYPICAL SECTIONS OF DAM	SEE PLATE - 3
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINS	SEE PLATES 3 & 6 NOT AVAILABLE

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM TUBMILL DAM
ID# NDS:488 DER:65-1

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	NONE
DESIGN REPORTS	NONE
GEOLOGY REPORTS	NONE . SUBSURFACE CONDITIONS ARE ILLUSTRATED IN A DESIGN DRAWING. SEE PLATE:4 A STATE REPORT DATED OCT. 23, 1914 REPORTS 25 TEST PITS WERE DUG FOR SUBSURFACE INVESTIGATION.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	NONE
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	NONE - SUBSURFACE CONDITIONS ARE ILLUSTRATED IN A DESIGN DRAWING. SEE PLATE-4

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM TOBMILL DAM
ID# NDS:488, DER:65-1

ITEM	REMARKS
POST CONSTRUCTION SURVEYS OF DAM	NONE OTHER THAN STATE INSPECTION REPORTS
BORROW SOURCES	UNKNOWN.
MONITORING SYSTEMS	NONE.
MODIFICATIONS	A RISER PIPE WAS INSTALLED TO THE SUPPLY MAIN IN ~1961. SEE PLATE-6 FOR DETAILS.
HIGH POOL RECORDS	NOT AVAILABLE.

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM TUBMILL DAM.
ID# NDS:~~488~~, DER:65-1

ITEM	REMARKS
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	NONE OTHER THAN STATE INSPECTION REPORTS.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	NONE FOUND OR REFERED.
MAINTENANCE OPERATION RECORDS	NOT AVAILABLE.
SPILLWAY PLAN SECTIONS DETAILS	SEE PLATE - 4 & 7
OPERATING EQUIPMENT PLANS AND DETAILS	SEE PLATE - 3

NAME OF DAM TUBMILL DAM

ID# NDS:488, DER 65-1

CHECKLIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: WOODED (10.7 SQ. MILES)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 614 ACRE-FT @ EL 1326

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): SAME AS ABOVE

ELEVATION MAXIMUM DESIGN POOL: 1326.5 (AS DESIGNED) USGS DATUM

ELEVATION TOP DAM: 1328.5 (AS DESIGNED) (USGS DATUM)

CREST:

a. Elevation 1328.5

b. Type CUT STONE

c. Width 6-FOOT 6-INCHES

d. Length 1100 FT

e. Location Spillover NO VISUALLY IDENTIFIABLE LOW SPOTS

f. Number and Type of Gates NONE

OUTLET WORKS:

a. Type 30"ϕ BLOW-OFF PIPE, 24"ϕ SUPPLY MAIN (CAST IRON)

b. Location ~100 FT RIGHT (LOOKING DOWN STREAM) OF SPILLWAY

c. Entrance Inverts $\mathbb{C}$ OF PIPE 1288 FT

d. Exit Inverts NOT REPORTED. ESTIMATED 1285 FT

e. Emergency Draindown Facilities 30"ϕ BLOW-OFF PIPE.

HYDROMETEOROLOGICAL GAGES:

a. Type NONE

b. Location N/A

c. Records N/A.

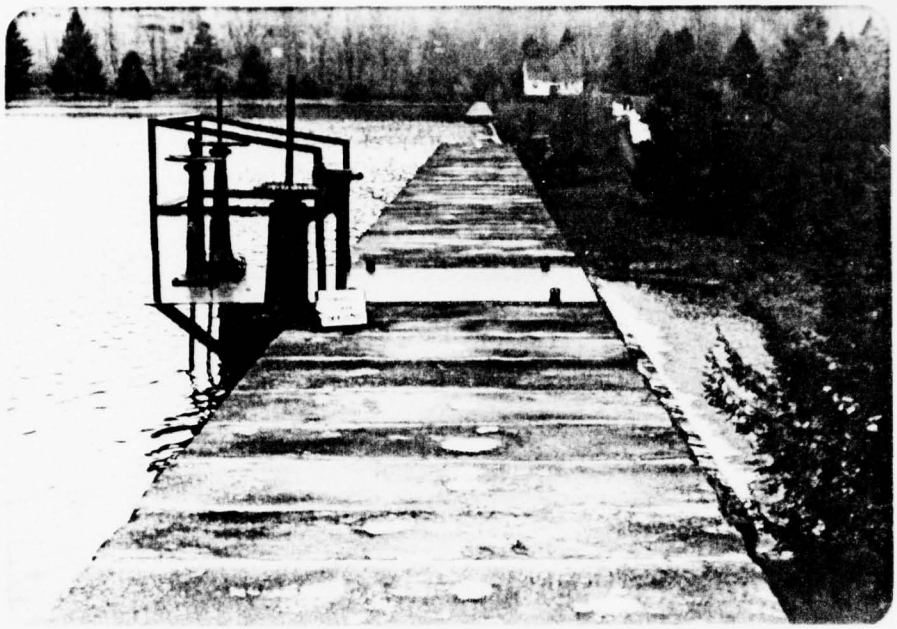
MAXIMUM NONDAMAGING DISCHARGE: _____

APPENDIX C

PHOTOGRAPHS

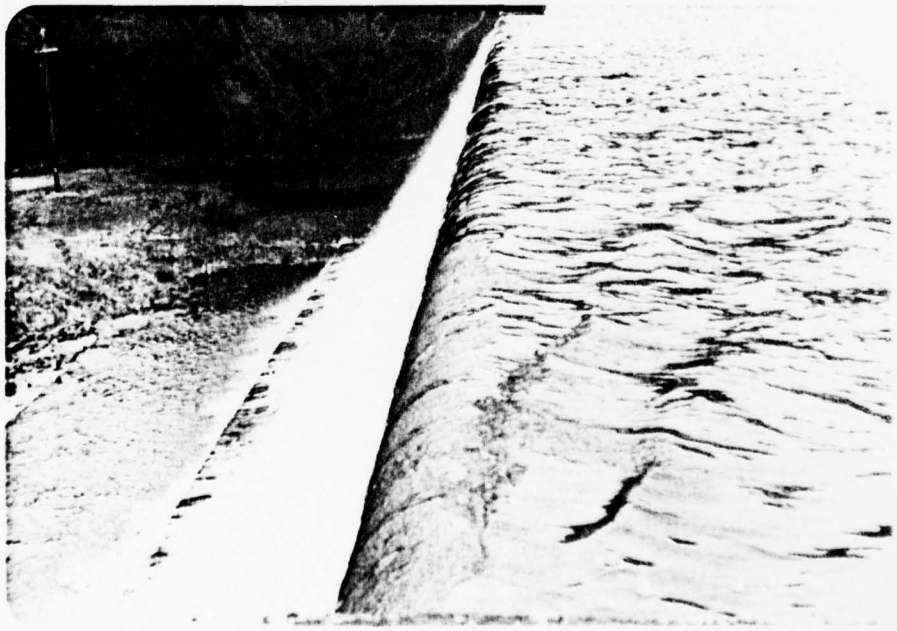
LIST OF PHOTOGRAPHS
TUBMILL DAM
NDS I.D. NO. 488
APRIL 25, 1978

PHOTOGRAPH NO.	DESCRIPTION
1	Crest.
2	Spillway.
3	Left abutment.
4	Right abutment.
5	Gate house.
6	"Blow-off" pipe operating.
7	"Blow-off" pipe discharge channel.
8	Seepage along right valley wall.
9	Seepage from the area shown in Photograph No. 8 discharging into "blow-off" pipe discharge channel through 6-inch I.D. clay pipe.
10	Typical seepage through the dam. Note precipitate buildup.
11	Flood plain along Route 711.
12	Bridge on Route 711.



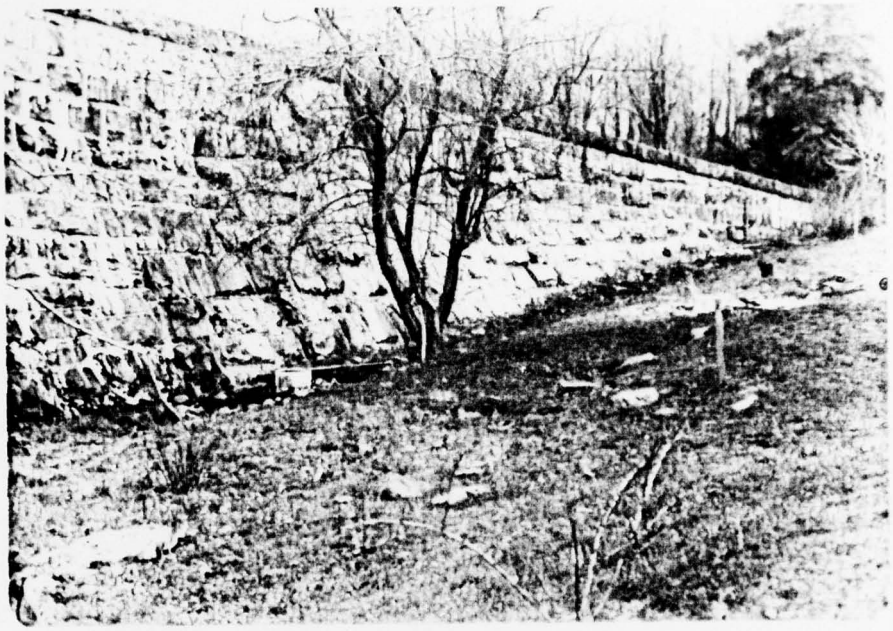
Photograph No. 1

Crest (looking west).



Photograph No. 2

Spillway.

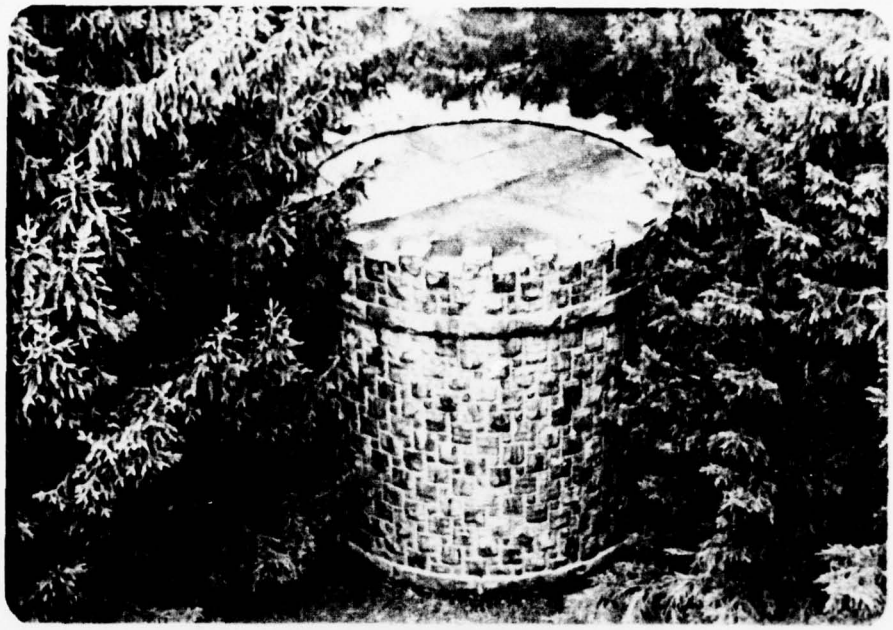


Photograph No. 3

Left abutment (looking west).

Photograph No. 4

Right abutment (looking east).

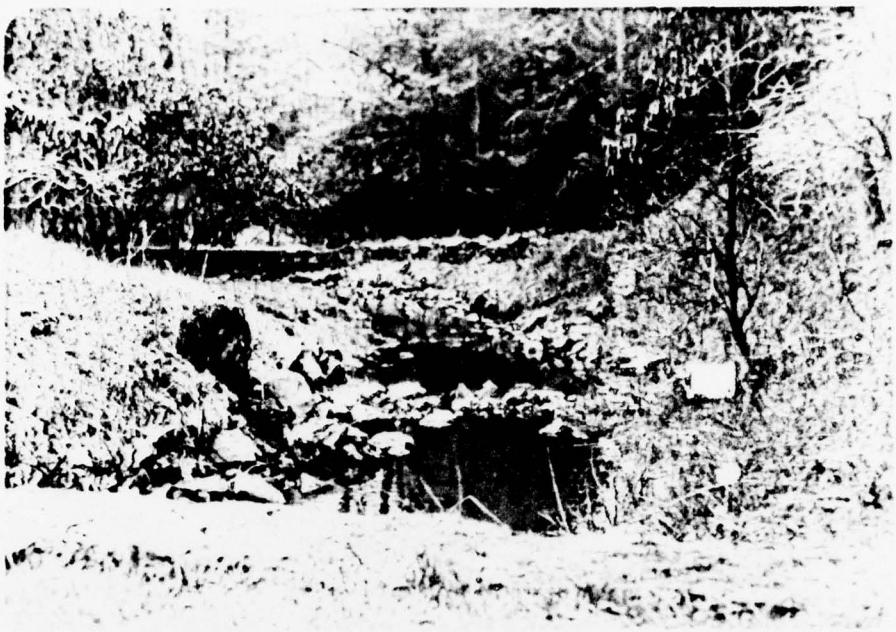


Photograph No. 5

Gate house.

Photograph No. 6

"Blow-off" pipe operating (pipe submerged).



Photograph No. 7

"Blow-off" pipe discharge channel. Seepage noted along channel behind the sign in the photograph.

Photograph No. 8

Seepage along right valley wall (see Plate 3). Note old weir in foreground.

Photograph No. 9

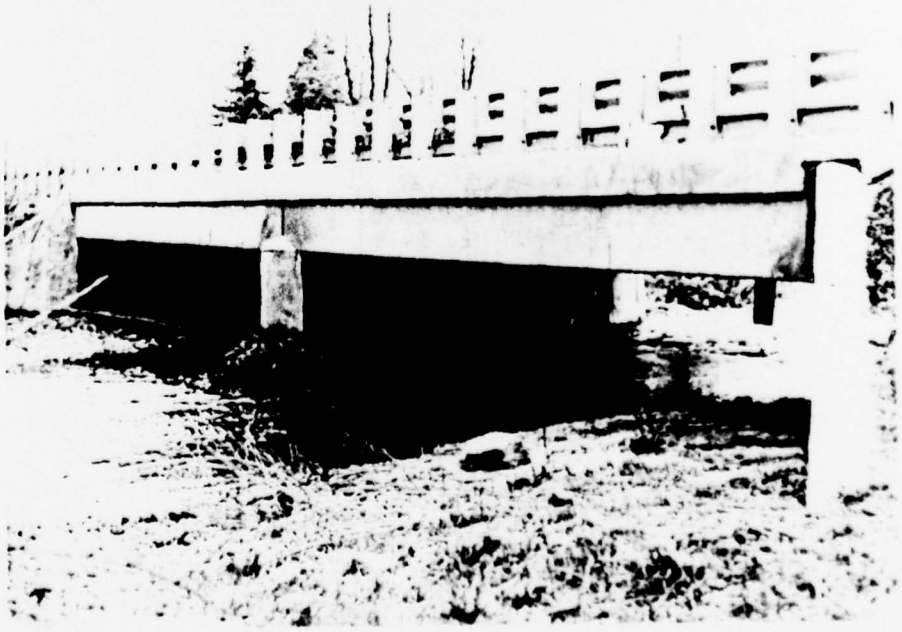
Seepage from the area shown in Photograph No. 8 discharging into "blow-off" pipe discharge channel through 6-inch I.D. clay pipe.

Photograph No. 10

Typical seepage through the dam. Note precipitate buildup.

Photograph No. 11

Flood plain along Route 711. (Note high school in left upper corner.)



Photograph No. 12

Bridge on Route 711.

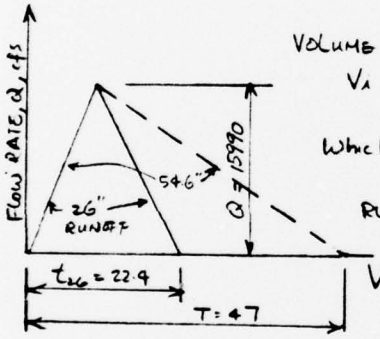
APPENDIX D
CALCULATIONS

D'APPOLONIA
CONSULTING ENGINEERS, INC

By WTC Date 6-21-78 Subject TUBHILL DAM, NDS 488 Sheet No 1 of 2
Chkd. By BE Date 6-21-78 HYDROLOGY & HYDRAULIC Proj. No 78-14-05

DAM: TUBHILL DAM, FAIRFIELD TOWNSHIP, WESTMORELAND COUNTY, Pa
NDS ID 488 DER 65-1
WATERSHED AREA A = 10.66 SQ. MILE

INFLOW HYDROGRAPH: OHIO RIVER BASIN, TUBHILL CREEK of CONEMAUGH RIVER
TOTAL TIME T = 47 HOURS
PMF PEAK FLOW q = 1500 cfs } FROM CHART PROVIDED BY BALTIMORE DISTRICT
$Q = qA$ = 15990 cfs



VOLUME OF INFLOW HYDROGRAPH
$V_I = \frac{1}{2} T \times Q \times 3600 \times \frac{1}{43560}$ AC-ft
= 31055 AC-ft
Which EQUAL TO $\frac{31055 \times 43560}{10.66(5280)^2} \times 12 = 54.6"$

RUNOFF, REVISED TO 26" RUNOFF in t_{26} HOUR
$V_I = \frac{26}{12}(10.66)(5280)^2 = 644 \times 10^6$ CF
= 14782 AC-ft
$t_{26} = \frac{644 \times 10^6}{\frac{1}{2} \times 15990 \times 3600} = 22.4$ hours

SPILLWAY CAPACITY

TYPE MASONARY WEIR C = 3.1 (ASSUMED)
LENGTH - L = 200 FT
$Q_S = CLh^{1.5}$
= 1754 cfs < ORIGINAL DESIGN Q = 1923 cfs
ACTUALLY THE DAM CREST COULD BE AN OVER FLOW WEIR
L = 1100 − 200 = 900 FT

$Q_S = (3.1)(200)(h+2)^{1.5} + (3.1)(900)(h)^{1.5}$ cfs
$= 620(h+2)^{1.5} + 2790\,h^{1.5}$ cfs

DAPPOLONIA
CONSULTING ENGINEERS, INC

By WJG Date 6-21-78 Subject TUBMILL DAM, NDS 483 Sheet No 2 of 2
Chkd. By BE Date 6-21-78 HYDROLOGY & HYDRAULIC Proj No 78-14-05

RESERVOIR CAPACITY ABOVE NORMAL POOL

$V_R = 41^{acre}$ (NORMAL POOL AREA) $\times 2$
$= 82^{ac\text{-}ft}$

REQ'D RESERVOIR STORAGE VOL FOR PMF

$= \left(1 - \frac{\text{MAX. SPILLWAY CAPACITY } Q_s}{\text{PMF PEAK FLOW } Q}\right)$ (VOL of INFLOW, V_i)

$= \left(1 - \frac{1754}{15990}\right)(14782)$

$= 13161^{ac\text{-}ft} >> 82^{ac\text{-}ft}$

THE DAM CREST WILL BE OVERTOPPED

DETERMINE WATER DEPTH h OVER DAM CREST FOR PMF

$$\frac{620(h+2)^{1.5} + 2790h^{1.5}}{15990} + \frac{41(h+2)}{14782} = 1$$

$h = 2.39$ FT ABOVE DAM CREST

$Q_s = 15980^{cfs}$

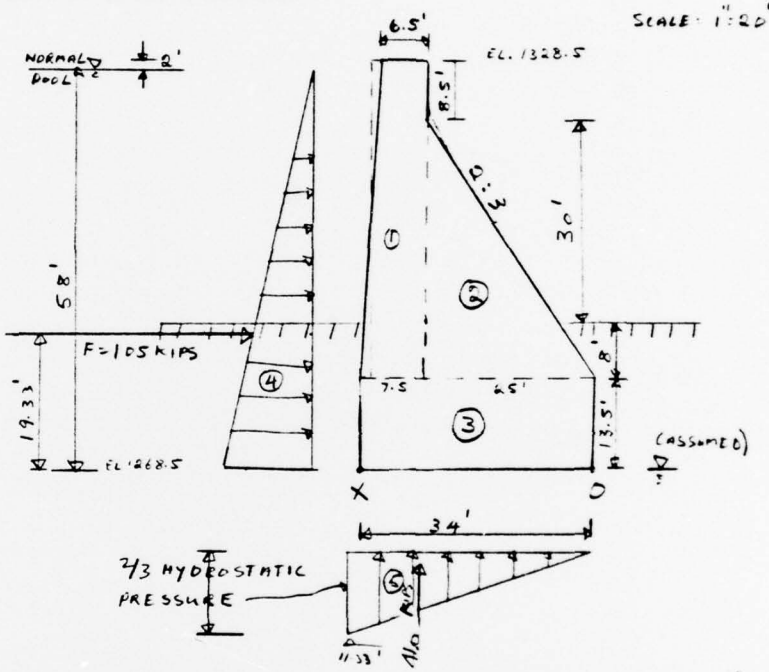
PERCENT PMF WITHOUT OVERTOPPING

$= \left(\frac{1754}{15990} + \frac{82}{14782}\right)100\% = 11.5\%$ PMF SAY 12%

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESA Date 6-5-78 Subject STABILITY ANALYSIS Sheet No 1 of 4
Chkd. By BE Date 6-7-78 THEMILL DAM Proj. No. 78-114-05

STABILITY WITH RESPECT TO OVERTURNING
— NORMAL POOL



PRESSURE AT UPSTREAM END (FULL HYDROSTATIC PRESSURE)
$= \gamma h = 62.4 \times 58 = 3619.2$ PSF
TOTAL FORCE: $\frac{1}{2}(3619.2) \times 58 = 105$ KIPS/FT

F = 105 KIPS FOR A ONE FOOT SECTION OF DAM

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESA Date 6-5-78 Subject STABILITY ANALYSIS Sheet No. 2 of 4
Chkd. By RE Date 6-2-78 TUBMILL DAM Proj. No 78-114-05

THE UPLIFT PRESSURE AT THE BASE OF THE DAM IS ASSUMED TO VARY FROM 2/3 HYDROSTATIC HEAD AT THE UPSTREAM END TO ZERO AT THE DOWNSTREAM END

TOTAL UPLIFT PRESSURE = $^2/_3 \times 3619.2 = 2412$ PSF
TOTAL FORCE = $2412 \times \frac{1}{2} \times 34 = 41$ KIPS

STABILITY WITH RESPECT TO OVERTURNING

RESISTING MOMENTS: MOMENTS ABOUT O

① $\underbrace{[46.5 \times 7.5 \times 0.150]}_{52.3} \times 28.75 = 1504$ K-FT

② $\underbrace{\left[\frac{1}{2}(25) \times 38 \times 0.150\right]}_{71.2} \times 16.67 = 1187.5$ K-FT

③ $\underbrace{[34 \times 13.5 \times 0.150]}_{69.9} \times 17 = 1170.5$ K-FT

3862 K-FT

OVERTURNING MOMENTS:

④ $105 \times 19.33 = 2029.7$ K-FT

⑤ $41 \times 22.67 = 929$ K-FT

2958.7 K-FT

$$FS = \frac{3862}{2958.7} = 1.31$$

FOUNDATION SHEAR STRESS = $\frac{P_h}{A}$

$$= \frac{105 \times 1000}{34 \times 144} = \boxed{21 \text{ PSI}}$$

D'APPOLONIA
CONSULTING ENGINEERS, INC

By ESH Date 6-5-78 Subject STABILITY ANALYSIS Sheet No. 3 of 4
Chkd By BE Date 6-2-78 TUBMILL DAM Proj. No. 78-114-05

FOUNDATION PRESSURE
(LOCATE RESULTANT ON BASE)

TAKING MOMENT ABOUT X
$\Sigma M_x = 0$ (+)

$R_y x - 105 \times 19.33 - 52.3 \times 5.25 - 71.3 \times 17.33 - 68.9 \times 17 + 41 \times 11.33$

$R_y x = 2029.7 + 274.6 + 1235.6 + 1171.3 - 464.5 = 4246.7$

$(R_y = (W_1 + W_2 + W_3) - 41 \text{ KIPS} = 152.4 \text{ KIPS}$

$x = 27.9$ (MEASURED FROM X)

∴ RESULTANT IS OUTSIDE MIDDLE THIRD

$e = 27.9 - 17.0 = 10.9$

$q_{MAX} = \frac{\Sigma V_{NET}}{BL}\left(1 + \frac{6e}{L}\right)$

$= \frac{152.4}{1 \times 34}\left(1 + \frac{6 \times 10.9}{34}\right) = \boxed{13.1 \text{ KSF}}$

$q_{MIN} = \frac{\Sigma V_{NET}}{BL}\left(1 - \frac{6e}{L}\right) = \boxed{-4.1 \text{ K/FT}^2}$

D'APPOLONIA
CONSULTING ENGINEERS, INC

By EA Date 6-2-78 Subject STABILITY ANALYSIS Sheet No 4 of 4
Chkd. By BE Date 6-21-78 TUBMILL DAM Proj. No 78-114-05

FACTOR OF SAFETY AGAINST OVERTURNING:—
(DAM OVERTOPPING BY 2.4 FEET (PMF)

∴ ADDITIONAL HYDROSTATIC PRESSURE = $4.4^{K} \times 0.0624^{K/ft^3} = 0.275^{K/ft^2}$
(2.4' + 2' = 4.4')

RESISTING MOMENT = 3862 K' (SAME AS FOR NORMAL POOL)

OVERTURNING MOMENT:

① DUE TO SIDE PRESSURE = $M_{(NORMAL\ POOL)} + \frac{0.275 \times h^2}{2}$

$= 2029.7 + \frac{0.275 \times 60^2}{2}$

$= 2524.7\ K'$

② DUE TO 2/3 HYDROSTATIC PRESSURE UPLIFT

$= \frac{1}{2}\left(\frac{2}{3} \times 62.4 \times 0.062\right) 34 \times \frac{2}{3} 34$

$= 993.9\ K'$

Σ OVERTURNING MOMENT = 3518.6 K'

$FS = \frac{3862}{3518.6} = \boxed{1.1}$

FOUNDATION SHEAR STRESS = $\frac{105^{K} + 62.4^{'} \times 0.162}{34 \times 144} = 0.024\ K/in^2$

$= \boxed{24\ PSI}$

APPENDIX E
REGIONAL GEOLOGY

APPENDIX E
REGIONAL GEOLOGY

The dam is on the west limb of the Laurel Hill Anticline with the rock strata dipping approximately 360 feet per mile to the west-northwest. The bedrock, consisting of the upper portion of the Allegheny Series, is probably the Butler Sandstone, a gray thin-bedded fine to medium-grained sandstone. The boney coal shown on the cross section (Plate 4) of the dam is the Lower Freeport coal seam. The Upper Freeport coal seam outcrops on the slopes above the floor of the reservoir and just below the dam. Available information (WPA maps) indicates no deep mining in the immediate vicinity of the dam.